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THE BOY ELECTRICIAN

RICK'S HEAD BEGAN TO LOOK SO FUNNY THAT TOM GRINNED AS HE LOOKED AT IT *Page 115*

THE BOY ELECTRICIAN

OR

THE SECRET SOCIETY OF THE JOLLY PHILOSOPHERS

BY

EDWIN J. HOUSTON, PH.D.
(PRINCETON)

WITH ILLUSTRATIONS BY
FRANK McKERNAN

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Preface

In "The Boy Electrician, or, The Secret Society of the Jolly Philosophers," a story is told of two Philadelphia Grammar School boys who, in addition to the fondness for baseball, swimming, and other athletic exercises, so common and natural to healthy, growing boys, possessed a marked liking for the natural sciences.

An experience of more than a quarter of a century in the school-room in the actual teaching of the natural sciences, has convinced the author that the average boy possesses a far greater fondness for these studies than is generally credited. Every live boy is anxious to understand the many things that are going on around him, and this is not limited to what his elders are talking about, but extends especially to natural phenomena.

There are many bright boys who for the lack of proper opportunities fail to have their scientific instincts awakened, and thus remain all their lives ignorant of the great scientific powers with which nature has endowed them.

In "The Boy Electrician, or, The Secret Society of the Jolly Philosophers," a story, full of fun and adventures, is told of two bright boys who possessed marked scientific powers that were not permitted to lie dormant. The remarkable and quaint doings of "The Jolly Philosophers," can hardly fail to be attractive to all boys.

If, as he hopes, the author succeeds in awakening in some of his boy readers, the marked scientific powers with which nature has endowed them, this book will not have been written in vain.

E. J. H.

June, 1907.

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Characters

Thomas Alva Bronson, "The Boy Electrician."
Richard Y. Justice, Jr., Tom's Chum.
Jamie Bronson, Tom's Young Brother.
Arthur Askinson, Principal of a Philadelphia Grammar School.
Ralph Coffin,
Alexander Jamieson,
Abraham Levy,
A. Phineas Skinner,
} Boy Friends of Tom and Rick.
Jerry Jones, An American District Telegraph Messenger Boy.
Mrs. Mary Bronson, Tom's Mother.
Richard Y. Justice, Sr., Rick's Father.
Charles S. Alexander, An Electrical Engineer in charge of one of Philadelphia's Electric Lighting Stations.
John P. Dodge, Chief Electrician of a large Philadelphia Power House.
Gideon Gordon, of The Western Union Telegraph Company.
William A. Harkenson, Lieutenant of a Philadelphia Police Station.
No. 481, one of Philadelphia's Police Force.
Michael O'Toole, in charge of a Boiler Room in the Lighting Station.
Park Guard No. 61.
John Hogan, a Blacksmith.
Ah Lung Sing, a Chinese Laundryman.

The Boy Electrician

I.

TOM BRONSON AND HIS CHUM, RICK JUSTICE

On a certain Saturday morning in early June, not many years ago, two schoolboys might have been seen in front of one of the large grammar schools in the northwestern part of Philadelphia, less than a mile from Strawberry Mansion, Fairmount Park. There was every evidence that the boys were interested in baseball; for, besides being dressed in baseball suits, there were two bats and a mask lying on the pavement near them.

Both boys were students of the grammar school in front of which they were waiting and belonged to its first or best baseball team. There was to be a match game that morning with a rival grammar school team, and the boys were waiting for some of their team who lived in the neighborhood.

One of the boys wore a baseball mitt, while the other, equipped with a glove, was holding a ball he was about to pitch to his companion.

A cloudy sky that threatened rain at any moment clearly gave the boys no little anxiety; for the boy who wore the mitt turned to his companion, and said:

"It looks like rain, Rick, don't it?"

"I'm afraid it does, Tom, but you don't want to give up the game and go home because it might rain, do you?"

"Give up and go home on a Saturday morning, when it is not yet nine o'clock! I like baseball too much, and Saturdays are too far apart to do such a thing for fear of getting wet. Besides, if our team don't show up, and the other team is on hand, we will forfeit the game."

"I hardly thought you would give up, Tom. You can make up your mind the other fellows will be there, rain or shine."

The boys were Thomas Alva Bronson, and Richard Y. Justice, Jr. Bronson was a well built lad of about 15. He had blue eyes and light, curly hair, and was rather large and heavy for his age. Richard, or Rick, as Tom called him, was somewhat younger than Tom. He had dark brown hair and black eyes, and was smaller and of a much slighter build. Both boys were in excellent physical condition, and were good ball players, as could be seen by the manner in which Rick delivered the ball, and the certainty with which Tom caught it, no matter what kind of curves were on it. Every now and then, in order to vary the exercise, Rick would deliver grounders to Tom; that is, instead of making the ball pass directly through the air, he caused it to roll over the ground. But Tom would always pick it up without letting it pass beyond him.

Both were studious boys, and were interested in the study of elementary physical science, Tom being especially interested in electricity. Though fond of athletic exercises, Tom did not spend all the time that remained after the preparation of his school work on the athletic field, but gave a fair amount of this time to reading about electricity from books taken out from one or another of the Free Libraries of Philadelphia. Tom was not alone in this extra work. Rick also devoted considerable time, although not as much as Bronson, to a similar study of physical science, but while interested, like his friend, in electrical studies, his special branch was chemistry.

Bronson was by far the better student of the two, although by no means the stronger boy intellectually. He had reached that time in a boy's life when his peculiar bent or talent had commenced decidedly to manifest itself. Justice, although only slightly younger, had not yet shown marked ability in any single direction, but that his talents lay in the direction of chemistry there could be but little doubt.

While both possessed a large store of the playfulness that characterizes young boys, Rick possessed this trait in a more marked degree than Tom. He was as playful as a kitten and full of pranks and jokes. He was much liked by all his schoolmates, who all agreed in saying of him:

"Rick's all right! There's sure to be some fun going on when he's around."

But it must not for a moment be supposed that Tom belonged to that undesirable type of boys who may correctly be described as little dried up old men; boys who take on the characteristics of manhood long before they have discarded their knee breeches, articles of dress, by the way, both the boys wore when not in their baseball suits. When you got to know Tom, you would certainly say that he was not that kind of boy. When at play, he fairly bubbled over with boyish activity, and was nearly as full of mischief as his friend, Rick, and this is saying no little. But Tom had matured more rapidly than Rick, and, at times, when his mind turned from play to his studies, he would take on an air of earnestness that appeared very funny to Rick because then Tom did look like an old man. Indeed, Rick would sometimes call him Grand-Dad, exclaiming:

"Come, Grand-Dad, don't look so old and withered."

Tom always took these remarks good-naturedly, and, as if to convince Rick by experience, that he was neither old nor dried up, would often catch him and throwing him on his back, administer a few good-natured thumps, saying:

"You'll call me Grand-Dad, will you? Then I must punish little Rick for his sauciness. Now will you be good?"

Under this discipline, Rick would shout with merriment, and cry out:

"Yes, I'll be good; for now you are my chum Tom."

From what we have said of Bronson, it is not surprising that besides increasing his knowledge of electricity by a careful reading of all suitable books he could obtain on the subject, he also spent no little time in making experiments in natural science, especially in electricity. He was an ingenious lad, sufficiently skilled in the use of tools to be able to construct far more elaborate devices than would be expected from one of his age. His parents, recognizing his mechanical ability, had provided him with a work-shop, which contained not only a carpenter's bench and tools, but also a small foot lathe, capable of shaping metals as well as wood.

There were two reasons why Tom had developed his electrical abilities at a comparatively early age. In the first place, he inherited his fondness for electricity from his father, who was an excellent amateur electrician and an ardent admirer of Thomas Alva Edison, the greatest electrical inventor the world has ever produced. Indeed, Tom's first and middle names, Thomas Alva, had been given him after the name of the great inventor. In the next place, Mr. Robert Askinson, the principal of the grammar school Tom had attended for more than two years, was a close student of the natural sciences, especially of electricity, and was, moreover, a member of the great Franklin Institute, and the American Philosophical Society.

Mr. Askinson, who was a splendid teacher, had succeeded in interesting his students in the natural sciences. He had found it possible, even in the limited time assigned to science lessons in the Philadelphia public schools, to give his students much valuable information in this direction, and arouse in them no little enthusiasm. It need hardly be said that Tom was Mr. Askinson's banner student in natural science. It was Mr. Askinson's teachings in this branch that had awakened in Tom the slumbering germs of the great scientific powers nature had so liberally bestowed on him.

Tom and Rick were close friends; or, as they liked to call themselves, "chums." Both were great readers, and enjoyed telling each other the curious things about which they had read, especially when, as was often the case, they had failed to thoroughly understand them. When this occurred, they either went to Mr. Askinson for help, or endeavored to solve the difficulties themselves by means of more or less wonderful experiments. When not in the schoolroom, or on the playground, they spent much of their time in Tom's workshop, or in each other's houses, which were only a few blocks apart.

But coming back to the boys as they tossed the ball to each other in the street in front of their school: Tom's answer, as regards giving up the game and going home, was evidently satisfactory to Rick; for, the passing of the ball to-and-fro continued. At last Tom cried to Rick:

"Send me a hot one, Rick."

Though slightly built, Rick was quite strong, especially in the arms and legs. He certainly did his best to send Tom a "hot" ball; for the ball he delivered had a splendid inshoot, and came with great swiftness. Tom caught it so squarely that it gave a resounding whack and made Tom's fingers tingle although protected by the mitt.

"That was a 'beaut,' Rick," exclaimed Tom. "Let's have another. See if you can put an outshoot on it."

The boys continued playing for a few minutes, when at last Rick held the ball he was just about to pitch to Tom and said:

"I wonder why the boys don't come. When were they to meet us here, Tom?"

"A quarter before nine, and now," said Tom, looking at his watch, "it is eight-fifty. You don't suppose that any of our team would let such a thing as a little rain keep them away, do you?" he added, anxiously.

"No," said Rick, who was a born wag. "You needn't fear any of our boys will stay away because it looks like rain, but it is just possible some of the boys' mothers might let such a little thing keep the boys indoors. Look at the clouds," he added.

It did, indeed, look like rain. Dark clouds were scurrying rapidly across the sky from the northeast, so the boys continued tossing the ball to each other, no little discouraged at the threatening appearance of the heavens. Fortunately, however, in a few minutes, with the rapidity that so often characterizes the summer storms in eastern Pennsylvania, the wind commenced to shift towards the northwest, patches of clear blue sky appeared, and the boys were soon bathed in a flood of glorious sunlight.

"Hurrah!" they cried, "it is going to clear after all."

"Yes," said Tom, "and here comes Abe Levy."

Abraham Levy, the boy referred to, one of their classmates, was one of the best players on their team. Abe had a curious impediment in his speech resulting from some defect in the nose, which, while permitting him to correctly pronounce all words that did not contain the nasal sounds, m, n, and ing, made him give a very odd pronunciation to words containing these letters, since he invariably pronounced the letter n as though it were d, and m as though it were b. When Abe first came to the school, and the teacher asked him his name, he replied:

"My dabe is Abrahab Levy," much to the amusement of the students who laughed aloud at his curious pronunciation.

Back of Levy were three other members of the team. These were Alexander Jamieson, A. Phineas Skinner, and Ralph Coffin.

Alexander Jamieson, who had only recently come to the United States from Scotland, spoke with a broad Scottish brogue. When the boys called him Alexander, he informed them that his name was Sandy. As Jamieson's hair was of a reddish color, the boys pretended to believe that the name was taken from the sandy or mud color of the hair, but Jamieson replied indignantly:

"I come frae bonny Scotland. Dinna ye ken that there, Alexander is called Sandy?"

So the boy was called "Sandy" from that day. He was a clever lad, but hot tempered, and often engaged in fights with the boys; but he was warm hearted, and was much liked by those who knew him.

The boy named A. Phineas Skinner was far from being a favorite with the rest of the team. His parents had recently made considerable money, and taken airs upon themselves. Instead of writing his name, Archibald P.

Skinner, he always insisted on being known as A. Phineas Skinner. The boys chaffed him unmercifully, taunting him with parting his name in the middle. But they let him play ball all the same, because he was a good ball player. They wanted a strong team, and, as is well known, in baseball, the team is selected only by reason of the ability of each boy to play ball, and that independent of race, social position, education, or sometimes even of color.

The remaining boy, Ralph Coffin, was a bright, merry, Yankee lad, who, like Tom and Rick, was full of fun and mischief, and was, moreover, both reliable and companionable. Although about the same age as Tom, Ralph was much older in his ways.

"Do you know anything about the other boys, Ralph?" enquired Tom.

"Yes," replied Ralph, "they went to the ball field early this morning to pick out and hold a good diamond. Let's go and meet them.

"All right," cried Rick, "I'm agreed."

II.

THE RUNAWAY

The boys at once started off at a rapid pace for the ball field, when Rick said to Tom:

"Wait a moment for me, Tom, I want to lace my shoes tighter." And then he added to the other boys: "Don't wait, Tom and I will catch up with you."

"I'm not going to take any risks, Tom," said Rick. "I remember once losing a run by having my lacing come undone, and this nearly lost the game. We want to win this game sure."

"That's right, Rick, and we will win it if we can. The other team can put up a first class game, but we'll do our best to win."

"Sure," said Rick.

It took Rick somewhat longer to tighten his shoe laces than he expected; for, by the time he and Tom had reached Dauphin Street, their companions were out of sight.

Walking rapidly towards the Dauphin Street entrance to the Park, and while still at a distance of one block from it, or, as we say in Philadelphia, one square, since in this city nearly all the principal streets cross one another at such distances apart as to make the blocks true squares, the clatter of horses' feet was heard and two horses dragging a carriage were seen dashing madly towards them. There was no driver on the front seat. The other seat was occupied by a lady who was so frightened that she was unable to do anything towards stopping the horses. It was a bad runaway, and unless the team could be stopped the horses might at any moment dash the wagon against the curbstone and kill its occupant.

"A runaway, Tom," cried Rick excitedly. "Let's try to stop the horses."

"All right, Rick," was the reply. "We'll stand in the middle of the street and try to attract the horses' attention. If they stop for a moment, we will jump at their heads and catch the bridles. I am heavier than you and will take the horse on the near side and you take the other or the off horse. When we once catch the bridles we must hold on tight. Look out the pole doesn't strike you. It would kill you sure."

As the team came tearing down the street there was as usual a crowd of people running after the maddened animals, while those in front ran away from them. The noise, especially that made by their running towards the team, only increased the animals' fright.

Seeing what the two boys intended to do, the people on the street instead of aiding them hurried out of the street and stood as near to the houses as possible, and then satisfied themselves with shouting:

"Look out, boys. Don't try to stop that team. You can't do it and will probably be killed."

The boys said nothing. Throwing down their bats, mitt, glove and mask, they stood quietly in the middle of the street, facing the approaching team and waving their hands in the air.

It was, indeed, a dangerous thing to attempt, but, at the same time, much of the danger was removed by the fact that they did not permit themselves to get excited. Indeed, this is one of the natural results of athletic training, especially in the playing of baseball; for, if a person is easily rattled, he may as well give up the idea of becoming a good ball player. To play baseball well one must keep cool. So the two boys stood, one on either side of the street, moving so as to keep the approaching team between them. They were apparently as cool as they would have been had they only been watching for a hot ball on the field, instead of a team of maddened horses.

The waving of the hands, while, as a rule, not calculated to stop a thoroughly frightened team, apparently so astonished the horses that when they drew near there was a momentary decrease in their speed. The two boys then sprang towards the horses' heads. As agreed, Tom caught the horse on the near side by the bridle and Rick the off horse; and succeeded, after being dragged some little distance, in stopping the team.

Now that the danger was over there was plenty of help. Several men who had stood close to the walls of the houses came into the street and helped to hold the horses and lift the lady out of the carriage. She was, however, still in too dazed a condition to thoroughly understand just what had happened.

As soon as the boys saw that the horses were securely held by men, Rick said quietly to Tom:

"Let's make ourselves scarce, Tom. I don't want to wait here to be thanked and praised, do you?"

"Not much, Rick," was the reply. "Let's get away now while every one is busy looking at the team and the lady."

In a few moments the boys were passing into the Park at the Dauphin Street entrance. Here, one of the Park guards, who was stationed at this place, said:

"That was a brave act, boys. I saw it distinctly from where I am standing. You took a great risk in stopping that team."

"That's all right, Charley," said Rick; "the lady might have been killed. We couldn't let the team run on; could we, Tom?"

"Certainly not," replied Tom. "But say nothing about it, please. Good-bye; we must hurry over to the ball field, or the boys will be wondering what has happened to us."

As the boys hurriedly left, Tom said to his companion:

"You appear to be acquainted with the guard, Rick. Have you known him long?"

"Yes, Tom," was the reply. "Father drives past him very often and always has a pleasant word with him. He is a very clever man. I think his name is Charley Rang. I call him by his first name, Charley, or by his number, which is 61."

They soon reached the great athletic field near Strawberry Mansion, or, as it is sometimes called, the Edgley Athletic Field, and joined their team. The boys said nothing about the occurrence. It was clear that none of them had heard anything about the runaway. One of the boys only called out to Rick, saying:

"Took you long enough to lace your shoes, Rick? Getting particular in your old age."

"That's it," said Rick, laughing.

Although it was only nine A.M., yet nearly all the diamonds were occupied, for the athletic field, belonging, as it does, to the city, is free to all, the first comers being at liberty to select any of the diamonds not in use. Since, however, the other boys of their team, and of the rival team, had gone to the field early, they had succeeded in pre-empting a splendid diamond near the northeastern corner.

Besides the two grammar school nines, there were many other teams on the field. These teams were composed mainly of boys whose ages ranged from twelve to sixteen. It would have been different had the game been called for the afternoon. Then, there would have been a greater number of adult teams; for, not a few of the greatest ball players in the country, both professional and amateur, received their early training on one or the other of the three great ball fields that have been set aside by the Fairmount Park Commissioners for the use of the lovers of our great national game and athletic purposes generally.

Tom, who was captain of his team, tossed up with the captain of the rival team to determine which side should go first to the bat. Tom won the toss and decided that the other team should bat first, thus giving his team the advantage of being last at the bat. Just before the game started, the score-keeper, having mislaid his lead pencil, tried to borrow a pencil from Tom, who, being dressed in his baseball suit, had left his pencil at home. Nor was the score-keeper more successful with the other boys. No pencil was to be had.

"Wait a moment," said Tom. "I think I can find something that will answer for a lead pencil." With that he crossed the drive extending along the eastern side of the field, and began looking carefully in the grass near one of the electric light poles that supported an arc lamp.

"What are you doing, Tom?" enquired the score-keeper, laughing. "You don't expect to find lead pencils growing in the grass, do you?"

Tom laughed good-naturedly in return and said:

"I suppose it doesn't make any difference what I get you for a pencil, if it will only make clear marks on your score-card."

"That's right, Tom," was the reply, "but I don't understand how you expect to find lead pencils in the grass."

Tom made no reply but continuing his search picked up several pieces of the carbons that had been employed for the arc lights. Examining them carefully he selected one of the pieces and handing it to the score-keeper, remarked:

"See if that won't mark the paper as well as a lead pencil."

The score-keeper tried it, and found no difficulty in making distinct markings on the paper closely resembling those made by a lead pencil.

"Bully for you, Tom," he replied. "You're a great fellow. Why this is very much like a lead pencil. What do you call it?"

"It is one of the carbons that was thrown out from the arc lamp over there," pointing towards the especial lamp, "when the lineman placed new carbons in the lamp," replied Tom. "The heat of the electricity has changed one end of the hard carbon into soft graphite, the material used in lead pencils. You will find the other end too hard to make any markings on the paper."

"That's so," replied the boys, trying it. "How long will this kind of lead pencil last?"

"Much longer than the game," was the reply.

Sandy Jamieson, who had been watching the use of the electric-light carbon, said:

"Aweel, aweel, it is wonderfu' what marks he makes wi' it. I dinna ken they made lead pencils so big and thick in America. It is a braw pencil."

"Is dot a pedcil?" enquired Abe Levy. "Let be look at it. Will it bark paper easily?"

The score-keeper, winking at Tom, laughingly handed Abe the piece of carbon, so that the soft end was towards him. Abe took it and endeavored to mark on the paper with the hard end.

"It's do good," he remarked. "It bakes do barks at all. Let me see how you bake it bark the paper."

"There is no difficulty in that," said the score-keeper, laughing, and taking the piece of carbon from Abe's hand, he used the other end which readily marked the paper.

"Dow I see," said Abe, who was a bright boy, "it odly barks at wud edd."

"Well, let's start," said Tom to the captain of the other nine. "Are you ready?"

"We're not ready, Bronson," was the reply. "One of our best players has sent word he will be late. Of course, you can have the game called now if you wish, but I hope you will give us a half or three quarters of an hour's time. What do you say?"

"I say certainly," replied Tom, "but of course the rest of the team must be considered. But they'll agree, I am sure, for we want to know which is the better team."

Calling his men together, Tom explained what was wanted.

"We'll leave it to you, captain," was their reply.

"Then," said Tom, "we'll give them the time. We want to win fairly; we won't force them to put a crippled team in the field."

"We'll wait," said Tom, going to the other captain.

"Thank you," said the captain.

It was nearly an hour before the missing player turned up. As soon as the other side notified Tom of their readiness, Tom turned to the umpire and said:

"You can call the game, now."

"It's about time," said the umpire, laughing. "Do you know you are nearly one hour late?"

"That's all right," said the captain of the other team. "This is Saturday, and we don't have to hurry."

III.

THE EDGLEY ATHLETIC FIELD NEAR STRAWBERRY MANSION, FAIRMOUNT PARK

On pleasant week days a well played game of baseball on the great Edgley Athletic Field, in Fairmount Park, is almost sure to draw a crowd of good-natured rooters. An excellent trolley service makes it easy to reach this portion of Philadelphia's famous pleasure grounds from almost any part of the city. But a game like that which was about to be played between two rival grammar school teams, both from the neighborhood, was sure to draw a great crowd. The boys of the two schools were out in full force. Indeed, on such occasions the girls, too, were in attendance. Then, too, delegations from distant schools were present in order to determine as to the wisdom of sending challenges to either of the teams.

Many of the spectators of both sexes carried the colors of one or the other of the two schools. That there was an unusual interest taken in the results of the approaching game might be seen by the enthusiastic waving of the opposing colors and the good-natured shouting of the cries of the two schools.

The delay in the game, instead of decreasing the size of the crowd, only tended to increase it; for, expending their enthusiasm in yelling, shouting and chaffing one another, the noise so increased that spectators came from other parts of the field, in the belief that an exciting game was going on. Nor did they leave when they found the game had not yet started; for, they saw the promise of a good game, and plenty of excitement, if nothing else, and, therefore, remained to see it.

The two teams were closely matched. Moreover, both played good ball, so good indeed, that at the end of the fourth inning the score was 0 to 0.

There was, therefore, clever playing on both sides and consequently great enthusiasm on the part of the rooters. This yelling increased in intensity until the ninth inning when a crisis had been reached.

At this time a well-built, active gentleman of probably 40, made his way as well as he could through the crowd near the batter and catcher. He appeared to be looking for some one. Seeing the crowd he said to himself:

"There is no use in my trying to find them now. I'll wait until the game is over."

While waiting he heard the umpire call, "ball three."

The bases were full. Should the pitcher give the batter his base on balls, it would force a run, leaving three men on bases. The situation was intense, so the gentleman was all the more willing to see the game out.

Rick was pitching. He did not seem to be at all nervous, notwithstanding the tight place in which he found himself, and the frantic efforts of the rival nine's adherents to "rattle" him.

Swift as an arrow sped the ball towards the catcher. Tom was waiting crouched behind the bat like a graven image in protector and mask. Surely the ball was going wide! But no, when it had almost reached the waiting batsman it curved over the plate in the neatest possible fashion, directly into the catcher's mitt.

"Strike one!"

A cheer rose from the pitcher's friends. The batter rubbed his hands in the dirt, sanded the bat, tapped it on the plate, and waved it back and forth menacingly. A casual spectator might have thought he was about to make the effort of his life to hit the ball. But he wasn't. He had a deep-rooted suspicion that there was a base on balls coming to him, and he proposed to wait for it. He was foxy, that batsman.

Again the ball shot in, this time directly towards the batter, who quickly bent back, to avoid being hit. As the ball curved outward, once more clean over the plate, he saw that he had been fooled and made a half-hearted and futile attempt to hit it.

"Strike two!"

This time the cheering was ear-splitting, but as the pitcher prepared once more to deliver the ball, a hush fell over the crowd, which a moment before had been shouting itself hoarse. The catcher held his hands just where the ball had landed twice before; just where it should land again.

"Good boy, Rick!" he called encouragingly. "Once more, now, for luck."

Whiz! The ball shot in with a speed that was marvelous, for the pitcher was only a boy. The batter was unable to tell from the delivery of this pitcher what sort of a curve, if any, was coming; perhaps also he was a bit "rattled." Be that as it may, he hesitated—and was lost; for the ball did not curve.

"Strike three! Batter out!"

Then the pent-up yells burst forth, and there was a frantic display of the school's colors. It is pleasant to note that Rick's clever pitching was heartily applauded even by the adherents of the rival nine.

That last "out" retired the side, and the two teams changed places.

The square-shouldered gentleman, who had been a keen observer of pitcher Rick's feat and had clapped his hands heartily, now moved over to the score-keeper, and asked what inning was about to be played.

"This is the ending of the ninth, sir," said the scorer.

"And the score?"

"Three to two, sir, in favor of the other fellows—the side which has just been retired."

"Ah!" said the gentleman. "Our friends at the bat must get busy."

"They must, indeed," was the reply. "But I guess they're good for a run or two. Tom Bronson and Rick Justice are both up this inning, and they are both good hitters."

"Who are they?"

"Their battery. Tom Bronson is catcher and captains the team. Rick Justice is pitcher."

"I see," the gentleman said, "they seem to be both first-class ball players, too. But I suppose they spend all their leisure time at it, don't they?"

"Oh, no," was the reply. "Of course, they play enough to keep in practice, for the sake of the nine; but they are both very much interested in the study of the natural sciences, and they spend a lot of their time in reading and experimenting. Tom's pet hobby is electricity, while Rick has a fondness for chemistry."

Just then the gentleman's eyes happened to rest upon the pencil—or, rather, the substitute for a pencil—which the scorer was using.

"I see, my lad, that you have discovered that an old electric light carbon can be used as a marking pencil. It is not every boy who knows that arc carbons, after they have been used in a lamp, are changed at the heated end into graphite. You know, that's the material used in the manufacture of lead pencils. Who first told you about this?"

"Tom Bronson," was the reply. "You see the players came in their uniforms, and when we were ready to start the game there wasn't a pencil in the crowd. So Tom ran across the drive and picked up several of the bits of carbon, that are thrown away by the lineman when he puts in new carbons."

"Tom must be an uncommonly bright fellow," said the gentleman.

"He is that," was the reply. "We call him the 'Boy Electrician,' and it isn't a josh either. He knows a lot about electricity."

While this conversation was in progress the ninth inning was started. The first batter up had been hit with a pitched ball and took his base. He then cleverly stole second. All eyes were on the next batter. A long single would score a run. But a groan arose as he popped the ball almost directly in front of the home plate, and the pitcher caught it.

"Runner out!" called the umpire.

Then Rick Justice came to the bat, and drove a clean single to right field. Unfortunately, the man on second tried to reach home on the hit, and was caught at the plate. The fates seemed to be playing against Rick and Tom.

One run was needed to tie the score, two to win. Rick was on base; two were already out. Would the batter prove equal to the occasion?

"Bronson! Bronson!" came the cries, as the young captain strode up to the plate. "Now, Tom! Lace it out, old boy!"

Tom looked determined. The pitcher promptly sent

TOM STEPPED FORWARD AND STRUCK THE BALL

in three balls, all wide of the rubber. Hoots and yells of derision came from the excited spectators.

"Pitcher's rattled!" cried an on-looker.

The scorer laughed: "He isn't rattled—not a bit of it," he said. "He's afraid of Tom, and means to give him his base."

Sure enough, the fourth ball wasn't over the plate either, for the pitcher carefully avoided putting it there. But Tom fooled him. He had watched this pitcher carefully, and felt reasonably certain that he could come pretty close to telling what sort of curve he was going to throw. When the ball sailed towards him this time, Tom stepped forward and struck at it with all his force.

Bang!

Far out to left field the ball flew, with the fielder hot in pursuit. Ordinarily, such a hit would have been a clean home run, but Tom Bronson's prowess as a batsman was well known, and the fielders had taken positions far out.

As soon as he got his hand on the ball he drove it to the shortstop, who wheeled and sent it flying to the catcher. Rick had no difficulty in reaching home, thus tying the score, and Tom had already rounded third base when, warned by the frantic coaches on the side-lines, he gave a headlong dive when a dozen feet from the home plate and slid there in a cloud of dust just as the ball struck the catcher's hands. Like a flash, the catcher touched the runner. From a little distance it looked as though the runner was out. The on-lookers held their breaths for the moment which intervened before the umpire gave his decision. Then it came, clear and distinct:

"Safe!"

Then pandemonium broke loose. Tom's side and their adherents were wild with joy, but some of the members of the other team and their friends disputed the decision and denounced it as unfair. Good feeling was restored, however, by the catcher, who came forward in a very manly fashion and acknowledged that the umpire was right.

After the two captains had held a brief conference to decide on the date of a return match, each team gave three cheers and a "tiger" for their late opponents, and then prepared to disperse.

While they were gathering up their bats and other paraphernalia Tom Bronson came over to the score-keeper. The square-shouldered gentleman who had taken such an interest in the game was still standing near the score-keeper. He went up to Tom and held out his hand.

"I want to congratulate you and your team on winning a hard-fought contest," he said, pleasantly.

"Thank you," returned Tom. "We are mighty glad to win. There's a strong rivalry between the schools—but it's good-natured."

"My young friend here tells me that you are interested in electricity as well as in baseball," the gentleman went on. "It is a subject with which I also am interested. My name is Charles S. Alexander. I am an electrician at one of the electric lighting stations in the city. Your name is Thomas Bronson, isn't it?"

"Yes, sir; Thomas Alva Bronson."

"That sounds as if you might have been named after the great inventor, Thomas Alva Edison," observed Mr. Alexander. "Are you related to him?"

"I was named for Mr. Edison," said Tom, "but I am not related to him. You see, my father knew him well, and considered him the greatest living inventor."

"Your father was right, Tom," said Mr. Alexander. "I, too, believe Mr. Edison to be the greatest inventor in the world. But tell me about yourself. Do you really find the study of electricity interesting?"

"Yes, indeed, sir," replied Tom, enthusiastically, "but I find it very hard. Many of the books on the subject I can't understand at all. Some of them are fairly plain, though, so I have learned something. Then the principal of our grammar school has taught me quite a good deal. When I come to things I don't understand, I sometimes get him to help me; but he is such a busy man that I don't feel that I ought to bother him very often."

"Well, Tom," said Mr. Alexander, "perhaps I may be able to help you a little, after we get better acquainted. By the way, how would you like to look through a large electric lighting station in the city?"

"That would be fine!" cried Tom.

"Well, I will be at our station this afternoon," said Mr. Alexander, giving Tom a card bearing his address. "If you come, enquire at the office for me, about two o'clock. Bring one of your boy friends with you if you wish."

"Thank you," said Tom, "I'll bring my chum, who studies electricity, with me."

"What!" exclaimed Mr. Alexander, laughing, "another electrician? Please introduce me to him, Tom."

"Certainly. This is my particular chum, Richard Y. Justice," replied Tom, beckoning Rick to him.

"I am glad to know you, Richard," said Mr. Alexander. "I am well acquainted with your father."

"Yes, sir," replied Rick, "I have often heard my father speak of you."

At this moment, Park Guard No. 61 came up to the gentleman and said something to him in a low tone.

"What!" exclaimed Mr. Alexander, excitedly; "these two boys?" pointing to Tom and Rick.

"Yes, sir," was the reply. "Those are the boys."

As their boy friends in the neighborhood heard these remarks, they began to wonder whether Tom and Rick had been getting themselves into any trouble. They were, however, soon more than satisfied; for, Mr. Alexander at once grasped a hand of both Tom and Rick and began shaking them warmly, remarking:

"Then it is to you two boys that I am indebted for the stopping of the runaway team this morning, and most probably, for saving the life of my wife who was in the carriage?"

"We are glad to have been able to stop the team. But please don't say anything more about it. All we did was to catch the horses by the reins and stop them. Any one might have done the same thing."

"Yes," was the reply, "any one might have, but no one did. We must become better acquainted, boys. I may be able to help you in the study of electricity."

As soon as the boys near them heard what Mr. Alexander said, they crowded around No. 61, who good-naturedly gave the full particulars of their brave act. When they heard just what had happened, they crowded around Tom and Rick and cried out enthusiastically:

"Three cheers for Tom Bronson and Rick Justice. They're all right," and then seizing the two boys good-naturedly, they mounted them on the shoulders of several of the older boys, and marched triumphantly with them around the diamond, shouting good-naturedly the two school cries one after the other.

"Thank you, boys," said Tom, "that'll do. Let us down now, please."

Mr. Alexander then calling Tom and the other captain to him said something to them in a low tone. Tom, smiling, said:

"Of course they would. Boys don't refuse such invitations," and then turning to the boys he called the two teams together and said:

"Boys, this gentleman, Mr. Alexander, wants to get acquainted with you. He wants to know whether you can meet him to-night at 8 P.M., at the confectioner's, Pflaumer Brothers, at 32nd and York Streets. He promises to set up as much ice cream and cake as you can eat. Will you come? All in favor will say aye."

"Aye," yelled all the boys.

"All right, boys," said Mr. Alexander. "Good-bye," he said, shaking hands with Tom and Rick. "I will expect you this afternoon at the lighting station."

As Mr. Alexander left the field, Tom said to Rick:

"Rick, you'll go with me to the electric lighting station, won't you?"

"Sure," replied Rick. "It isn't every day one gets an invitation to go through a place like that. Say, Tom, if we keep our eyes open, we should have no trouble in finding good subjects for our oral compositions."

Just what this oral composition was to which Rick referred will be explained in another chapter.

IV.

THE ELECTRIC LIGHTING STATION

After dinner, on the day of the baseball match game, Tom and Rick walked to the electric lighting station. It was far from where they lived, but they never for a moment thought of taking the trolley cars; for, the four cents and a fraction, the cost of a single car fare in Philadelphia, could be expended in a far more satisfactory manner. This was especially true with Tom, who was generally in need of spare cash for buying the things necessary for his many experiments.

Both boys were in splendid health, and greatly enjoyed the walk. They had so many things to talk about that they were soon in front of the main entrance to the station. Here they saw a sign,

"NO ADMITTANCE, EXCEPT BY PASS FROM THE GENERAL OFFICE."

On entering the office Tom enquired for Mr. Alexander. The attendant at first hesitated to take a message from a boy. When asked the nature of their business, Tom replied:

"Please say to Mr. Alexander that the boys with whom he was talking this morning on the Edgley ball field wish to see him."

The attendant smiled on receiving the message. Hesitating no longer, he went into a private office, from which he soon returned saying that Mr. Alexander would see them in a few minutes.

In a short time, an electric call bell rang, when the attendant said:

"Mr. Alexander will see you now," taking them into the private office.

"Good afternoon, boys," said Mr. Alexander. "I am glad you came early, as I can spare the time just now to go with you myself through the station. We don't generally permit visitors to go through the station, since, unless one is very careful, serious accidents might occur. But there is no danger if you are careful not to touch anything in the different rooms. We will begin at the top," continued Mr. Alexander, leading them to an elevator which took them near the top of the high building that formed the station."

On getting out the boys found themselves in a room used for receiving coal, two streams of which were continually falling to the floor from a device he told them was called a conveyer. It consisted of an endless belt, provided with buckets or carriers. The belt, being moved by machinery, raised the coal from the street below to near the top of the room. As the vertically moving buckets turned to cross the room horizontally, they emptied the coal they contained into a bin on the floor communicating with the rooms below, where the steam boilers were placed. As the boys stood looking at the coal they could see that it was falling into some space below; for, it was lower in the middle than at the sides, and could be seen slowly moving from the sides towards the middle.

"It would be dangerous," said Mr. Alexander, "to fall into that pile of coal, since, if the coal was being drawn into the rooms below, as you can see is now being done, one might easily be sucked into the mass and smothered."

After they examined the action of the conveyer, Mr. Alexander said:

"We will now go to the boiler room where the coal is being burned," and leading the way down a circular staircase, he brought them into a large room with steam boilers on one side, and a number of men shovelling coal into the fires under the boilers. "Here," said Mr. Alexander, "is where the coal is eaten up. Our daily consumption during last November was one hundred and forty-three tons. There is, therefore, a large quantity of exhaust steam escaping from the engines. This steam is not wasted, but is led through pipes running under the streets to a number of large buildings in the neighborhood," mentioning a hospital, a number of big newspaper buildings, and a large department store. "In this way we not only save coal and valuable floor space for our customers, but also lessen the fire risks on the buildings which are so heated."

From the boiler room they descended to the floor below, where there was a second boiler room.

While examining the boilers, Mr. Alexander was called away to attend to something in another part of the station. Calling a good-natured Irishman, who was in charge of the room, he said:

"Boys, this is Michael O'Toole. Michael, these lads are friends of mine. I have been showing them the station. Look after them while I am away, and tell them all you can about the boilers."

"Oi'll be plased to do so," replied Michael. He then explained how the coal was stoked, or spread over the fires under the boilers; called their attention to the gauges for indicating the steam pressure on the boilers; and showed them the tubes placed on the sides of each boiler for indicating the height of the water in the boiler. He also explained the means for forcing the water into the boiler against the pressure of the steam it contained.

Michael took so much pains with the boys, and made the time pass so pleasantly, that when Mr. Alexander returned they were surprised to learn that he had been absent for half an hour.

"Well, boys," he enquired good-naturedly, "how has Michael treated you? Have you learned anything?"

"Splendidly," replied Tom and Rick, "and we have learned much."

"And, Michael," he enquired, turning to the Irishman, "how did you find the boys, bright or stupid? Have you been able to teach them anything?"

"They are broight biys, bedad," was the reply. "I have taught them no little. Indade, I don't belave they would have been broighter had they come from the ould country."

Bidding Michael good day they continued their way down the circular stair-case to a lower floor, where Mr. Alexander led them into a small room. Taking off his watch, he said:

"You had better leave your watches here with mine. They would be injured by magnetism if you carried them through the generating room where we are now going."

He then led the boys into a large room in which there were many big machines, called dynamos or generators, by means of which the mechanical energy of the steam engines is changed into electrical energy.

"This is an old station," said Mr. Alexander. "As you can see, we have dynamos or generators, driven by means of belts, as well as by direct connection with the steam engines. These," continued Mr. Alexander, pointing to some of the more modern machines, "are of the type known as direct-connected generators. Formerly, all generators were driven by means of belting that took its driving power from lines of shafting such as those," he said, pointing to a number of large belt-driven machines. "Now, however, all large generators have their dynamos direct-connected; *i.e.,* their driving shafts are directly connected with the driving shaft of the steam engine."

Mr. Alexander then clearly explained to them in simple language the different parts of the machine.

The old type of belt-driven machines, although running smoothly, made considerable noise, so that the boys had difficulty in hearing what Mr. Alexander was saying. Some of these machines, however, were not running; for, during the early afternoon in summer, the call for electric current is comparatively small. The dynamos that were producing current ran so smoothly that had it not been for the motion of the driving engine, it would have been difficult in some cases to know whether the machines were at rest or in motion.

"You can see," said Mr. Alexander, "that it is difficult to know whether a machine is running or not. Should one be so foolish as to place his hand on a machine in motion, in order to determine whether it was at rest or in motion, he would probably lose his hand and possibly his life."

"Mr. Alexander," enquired Tom, "do you keep these extra machines in case of accidents to any of the machines?"

"No, my lad," was the reply, "nearly all the machines you now see at rest will be employed for supplying electric current towards sunset, when there is a great call for current because the electric lights are then turned on in the streets and in the large buildings. This is especially true about five o'clock on winter nights, when, as the sun sets at an early hour, the hotels and office buildings are all lighted. There is then a great call for electric current and we have to run every machine in the station."

"Then during the summer you don't have to employ all the machines or generators?" asked Tom.

"Your question shows much thought, Tom," replied Mr. Alexander. "If we had a sufficient number of generators to supply all the current required during winter evenings, there would be many dynamos out of use during summer. This, of course, would greatly decrease our earnings. To avoid this, nearly all large stations are now provided with what are called storage batteries, by means of which it is possible to store up electric energy. By the use of these batteries we are able to run some of these extra machines during the middle of the day, or at such times when but little current is needed. When the call for current becomes greater, we throw in the current from the storage batteries, thus adding it to the current from the machines. In this way we get along with fewer machines than would otherwise be possible. I will show you the storage battery room after awhile."

Tom and Rick stood looking at the generators as they were producing the powerful currents employed for operating the arc and incandescent lamps in the neighborhood. This was the first time they had ever seen such machines in operation. They seemed so complex that the boys despaired of ever being able to understand how they operated. Seeing the puzzled look on their faces, Mr. Alexander said:

"Suppose I give you a short description of these machines and how they operate."

"I wish you would," said Tom excitedly.

"Well," said Mr. Alexander, good-naturedly, "let's take these old forms of belt-driven generators," pointing to some old machines. "They are of a type invented by Thomas Alva Edison, the great man, Tom, after whom you were named. They were so well designed that we are still running them alongside much more modern machines. These generators consist of three parts, the field magnets, the armatures, and the commutator and collecting brushes.

"The field magnets are powerful electro-magnets, provided at their poles with pieces of soft iron called pole-pieces. The magnet cores consist of masses of cast iron, or cast steel, wrapped with coils of insulated wire. When the machine is in operation the electric current passing through the coils on the field magnets produce streamings called magnetism, or magnetic flux, that flows between the pole-pieces.

"This," he said, pointing to a cylindrical mass covered with insulated wire, "is the armature. As you see, it is shaped so as to come close to the surface of the pole-pieces of the field magnets, as it is rapidly spun or turned by the driving belt. The armature consists of a mass of soft iron built up of a number of separate discs. An electric current is produced in the insulated wires wound on the surface of the armature, as they are forced to move through the magnetic flux passing between the pole-pieces. It requires considerable mechanical energy to turn the armature when the magnetism is passing between the pole-pieces. It is this energy that is changed into electrical energy.

"The current produced in the armature changes or alternates in direction, during rotation, flowing in one direction for a short time, and then suddenly flowing in the opposite direction. Such electric currents are called alternating currents, and are now often employed for both lighting and heating. In this machine, however, before being used the alternating currents are changed into direct currents, that is to say, they are caused to flow in one and the same direction. The device for doing this is called the commutator.

"This is the commutator," he said, pointing to a part of the machine on which brushes were resting. Occasionally bright sparks could be seen passing between the commutator and the brushes.

"You must not suppose, my lads," he said, laughing, "as I have heard ignorant people assert, that a dynamo or generator acts on the same principle as the frictional electric machine; that it is the rubbing of the brushes against the commutator which produces the current. All the brushes do is to carry the current, that has already been produced in the armature, to the different devices, such as arc or incandescent lamps, electric fans, motors, heaters, etc., that are to be operated by it."

Then turning to Tom, he said:

"Tom, can you tell me the three principal parts of a dynamo?"

"I think I can, sir," replied Tom, "they are the field magnets, for producing the magnetism through which the armature passes; the armature in which the electric currents are produced, and the commutator and brushes, by means of which the currents produced in the armature are caused to flow in the one and the same direction, and are afterwards led off so as to operate devices outside the machine."

"Bravo, Tom," replied Mr. Alexander. "I'm glad to find you are so bright and quick."

Mr. Alexander then showed the boys the heavy wires or cables by which the currents produced by the dynamos are led to a device called a switch-board, by means of which it is readily caused to flow through different circuits. There were a number of electrical measuring instruments on the switch-board called ammeters, which give the amount of electricity flowing through the circuit in a given time, and voltmeters, for showing the electric pressure produced by the different generators. There were also on the back of the switch-board other instruments called wattmeters by means of which the amount of electric power transmitted was recorded.

Mr. Alexander then took the boys into a room where a number of arc lamps were being adjusted.

As the boys entered this room they were almost blinded by the dazzling light.

"This is the arc-lamp adjusting room," he said. "The arc lamps burning here are being adjusted so as to burn properly when placed together on a circuit." He then explained the mechanism of a lamp, and the changes that take place in the two carbons under the influence of the heat of the arc. Each arc lamp is provided with a mechanism by means of which two vertical carbon rods that touch each other when no current is passing, are, by the action of an electro-magnet, moved a short distance apart as soon as the current flows through the lamp, when a brilliant arc or bow of light appears between them. This is the carbon arc light, and is employed for lighting the streets and, to some extent, for large halls.

But both Tom and Rick were especially pleased when, going to a wooden box placed in one corner of the room, Mr. Alexander selected some ten or twelve pieces of burned carbons, and gave them to the boys, pointing out to them the difference in the appearance of the positive carbon, or that out from which the current flows during the operation of the lamp, and the negative carbon, or that into which the current flows after its passage through the arc. He thoroughly explained to them the manner in which these shapes had been acquired.

The great number of arc lamps in the room surprised Tom, who counted no less than sixty separate lamps. There was something, however, that seemed to greatly bother him. As far as he could see, all the lamps were connected to a single conducting wire that entered the room near the ceiling at one wall and left it at the opposite wall. The separate lamps appeared to be placed on the line wire in breaks in the wire, so that the current, on entering the room from the machine, flowed through the first lamp, then passed on to the next lamp, then to the next, and so on to the last lamp, when it left the room and flowed back to the machine. The puzzled look on Tom's face was observed by Mr. Alexander, who had been quietly watching him, and who at last said:

"Well, Tom, what is the trouble? Perhaps, I can help you."

"I was wondering how you keep all the lamps from going out if one of them should go out," replied Tom.

"What's the trouble?" enquired Mr. Alexander, who wished to find how far Tom had puzzled the matter out for himself.

"Why, all the lamps are on a single wire, are they not? The electricity comes in at one end of that wire," pointing to the wire on which the lamps were placed, "and then goes out at the other end, does it not?"

"That's right, Tom," said Mr. Alexander, "but what of that?"

"Well, the current passes from one lamp to another, just like steam passes from one steam radiator to another when employed for heating a room."

"That's so, but why does that trouble you?"

"Because," continued Tom, "if one steam radiator should become stopped-up, or broken, the steam would fail to pass through the others. It seems to me, in the same way, that if the electricity fails to pass through one of the lamps all the other lamps should go out."

"Yes, Tom, that's right, but still I ask what's the trouble?"

"Well," said Tom, "the trouble is they don't go out. I have been watching them. Now and then, one of the lamps does go out. I hear a little click, but all the other lamps continue burning. I can't puzzle it out."

"Bravo, Tom," replied Mr. Alexander. "You are certainly a close observer. You are quite correct in your reasoning. The lamps would go out if some bright man had not provided a means for keeping them in the circuit."

He then explained to Tom, the manner in which an ingenious device, called an automatic cut-out, acted to provide a path past a faulty lamp so as to permit it to be removed from the circuit without affecting the remaining lamps.

"Besides this device," he continued, "the lamps are provided with a hand switch. See here, Tom," he said, pointing to a simple switch placed at the top of the lamp, "by moving this switch the current is able to flow past a faulty lamp. See," he continued, opening the switch, when the lamp immediately went out, without, however, affecting any of the others. He then closed the switch by turning it in an opposite direction, when the lamp was again relighted.

"Turn the switch, Tom. There is no danger if you are careful not to take hold of the lamp with your other hand, or to permit any part of the circuit to come in contact with your body through the feet or otherwise. Take hold of the black handle of the switch and move it towards the other piece of metal."

Tom did this, and the light was immediately extinguished. Then turning it again in the opposite direction, it was immediately relighted.

"A hand switch is often very convenient," continued Mr. Alexander, "since sometimes the automatic device does not act. These switches are generally placed on all in-door arc-lamps, and are either operated by the hand, or by means of a pole. Besides, by cutting the lamp out of the circuit," he continued, "one can handle it safely. The electric pressure necessary to feed so many lamps is so great that if it should accidentally pass through one's body, it would cause instant death. Let us now go into the storage battery room," said Mr. Alexander.

On hearing this, Rick was very much pleased; for, as already mentioned, he was especially interested in chemistry, a branch of science it is necessary to study in order to understand the changes which take place during the charging and discharging of the battery.

Mr. Alexander told the boys that storage batteries consist practically of plates of sheet lead immersed vertically in a mixture of sulphuric acid and water contained in huge vats. He then explained to them the manner in which the batteries are charged, as well as the changes that occurred in their plates while charging and discharging.

Passing out of the storage battery room, Mr. Alexander then took them into a small room containing a drawing table and a desk. Here he showed them plans of some of the different underground conductors that lead from the station through the different streets of the city.

"We keep here, plans of all the connections of our different underground wires. We are constantly making changes in the number and distribution of these wires, as well as their connections to the different buildings. Unless we did this we would soon lose track of the different circuits. It would give us great trouble if any of these plans should be lost or destroyed."

Just as Mr. Alexander had completed his explanation he was called from the room. As he left, he said to the boys:

"Wait here for me. I will return in about five minutes or so."

The room was lighted by an arc lamp instead of incandescent lamps, thus permitting the making of photographic blue prints as copies of their plans or drawings. The lamp was placed near one end of the room in such a position that its light could readily fall on the surface of the photographic paper employed for copying the drawings. Although an old lamp, it served its purpose satisfactorily, giving ample light for printing.

There were a number of wooden shelves in this part of the room on which were piled some of the old plans, and books of correspondence concerning changes in the directions and connections of the circuits.

A few moments after Mr. Alexander left the room the arc lamp began to behave badly. Its upper carbon stuck, or failed to fall towards the lower carbon. The distance between the two carbons, therefore, increased, so that the length of the arc became greater than usual, began to flame, and before long to play dangerously near the wooden shelf and some paper records in its neighborhood. The boys watched the lamp as its flame grew longer and longer. In a short time the paper began to smoke and at last broke out into a bright flame.

Without any hesitation Tom tried to turn the hand switch, so as to cut the lamp out of the circuit, but the flame of the arc was so long that he was unable to touch the switch handle without being burned. He therefore took up a wooden ruler that was lying on the drawing table, and by its use succeeded in closing the switch thus cutting the lamp out of the circuit, when, of course, the arc immediately disappeared. The two boys were then able, although with difficulty, to beat out the flame before much damage had been done either to the plans or to the wooden shelf.

They had just completed this work when Mr. Alexander returned. Finding the room full of smoke and the boys somewhat blown by reason of their exertions, he enquired.

"What's the trouble, boys?" Then seeing the arc lamp out and its hand switch closed, the charred paper, and woodwork in the neighborhood, he exclaimed:

"All right; I understand what has happened. You turned out that arc lamp when it drew too long an arc and was beginning to set fire to the room; am I right?"

"Yes, sir," replied Tom. "It was the only way in which we could put out the fire. I hope I have acted properly."

"Acted properly!" exclaimed Mr. Alexander. "You have certainly saved very valuable papers; indeed, possibly our entire building. You have done just what I should have done, so I am again indebted to you, Tom, for your coolness and presence of mind. That was a dangerous lamp. I had already given orders to have it replaced by a newer lamp. This was about to be done to-day."

After seeing that everything was safe and calling an attendant to remain in the room, Mr. Alexander said, "this is all the time I can give you to-day. Come into the room where you left your watches."

"Mr. Alexander," asked Rick, "what would have happened to our watches had we carried them into the generating room?"

"They would have been injured by the magnetism of the machines. Come, I'll show you," he added, leading them back to the generating room. "No," he said, as he saw that Rick was putting his watch in his pocket, "leave your watch here or it will be injured."

On reaching the generating room, he told one of the workmen to bring him a monkey-wrench, and holding its mass of soft iron to the outside of one of the pole pieces of an Edison machine, it was held there so strongly by the magnetism that they were hardly able to pull it off.

"If you had your watches in your pockets when you passed near this machine, all their steel portions would have been magnetized, thus greatly affecting the time-keeping. Let me have your penknives a moment, boys," he added.

Holding the knives for a moment against the pole pieces, he handed them back again to the boys, saying:

"Now, your penknives are magnetized as strong as they can be."

"How long will they keep their magnetism, Mr. Alexander?" asked Tom.

"That depends," said Mr. Alexander. "If the blades are made of good, hard steel, they will never forget that I have magnetized them, but if they are made of soft iron or soft steel, they will almost instantly lose their magnetism."

They then returned to the room where they had left their watches and got them and bid Mr. Alexander good day.

"Come again, boys, whenever you feel like it. If I am busy I will tell you so. Saturday afternoons are generally the best time to call, as then I am not generally engaged. But don't forget your engagement to-night at the ice-cream parlor."

"There's no danger of that, sir," said both boys laughing.

There were great times at Pflaumer's that evening. Every boy on the two teams was present. As he had promised, Mr. Alexander gave the boys all the ice cream and cake they could eat, and this, as he discovered, was by no means a small quantity. But the more the boys ate the more did Mr. Alexander appear to be pleased, so the boys did all they could to please him and voted him a splendid man.

V.

TOM'S LABORATORY. SOME EXPERIMENTS IN MAGNETISM

As Tom and Rick walked home after leaving the electric lighting station, they talked about the many wonderful things they had seen. They were especially impressed by the size of the station, and the great quantity of coal that was burned every day in order to produce the electricity.

"Rick," remarked Tom, "had you any idea that we were to see so big a building?"

"No, I had not," was the reply, "and yet I have heard father, who is a stockholder in the electric lighting company that owns this station, say that it is only one of a number of stations in Philadelphia, and by no means the largest. The electric business must be a great business, Tom."

"It must, indeed," replied Tom. "I have always intended to be an electrician. But after what I have seen to-day I am more determined to do so than ever. I shall now try harder than ever to learn as much about electricity as I can."

"That's the way to talk, my boy," replied Rick enthusiastically. "Make up your mind and I am sure you'll do it; for, electricity seems to come natural to you. I am going to study it more myself."

"Thank you, Rick. But ain't Mr. Alexander a splendid man, taking so much of his time to show us the station. Then didn't he make things plain when he described them?

I am sure that I understand the general operation of dynamos or generators with their three principal parts."

"Yes," replied Rick, "he certainly can make things plain. I think I understand what he said about dynamos myself."

When the boys drew near their homes, Tom said:

"It is early, Rick. Come over to my work-shop, and we'll see if our penknives are still magnetized. You remember what Mr. Alexander said, 'if your penknives are made of good, hard steel, they will never forget that I have magnetized them.'"

"All right. Let's go and see."

Tom Bronson lived with his mother, and little brother, Jamie, in a comfortable two-story house, a little less than a mile northeast of Strawberry Mansion. His father had died shortly after the birth of Jamie, who was now four years old, Tom and Jamie being the only children. Mrs. Mary Bronson, Tom's mother, lived alone with her two children, so that the two-story house was large enough for them. She was well enough off to have lived in a somewhat larger house, but she preferred remaining where her husband had spent the last years of his life.

Mr. Bronson had been a carpenter and builder. His work-shop was situated at the rear of a fairly large yard that extended to a small back street. It was a two-story building with only two large rooms, one on the ground floor, and one on the second floor. The upper room had been assigned to Tom as a work-shop; or, as Tom liked to call it, his laboratory. The lower floor had been rented to a relative for the storing of household goods, but since the second floor was accessible by means of an outside staircase, Tom had free access to his work-shop without passing through the lower room on the ground floor, although the two rooms were connected with each other by an inside stair-case.

Tom's laboratory, as we shall hereafter call it, was splendidly lighted, there being three fairly large windows, one in each of the three sides, and a large sash door facing the back street. The wall, immediately above the door, was provided with a beam projecting out towards the street. A strong hook had been attached to the end of the beam for the support of the block and tackle, that had been employed by his father for hoisting lumber and other materials from the street to the second story. A good-sized carpenter's bench was placed against one of the walls, and a foot lathe, capable of working either metal or wood, against the opposite wall. Both the bench and the lathe were placed near the windows so that the work was well lighted. There was a small stove in one corner of the room, capable of burning either coal or wood, the pipe of which was inserted in a chimney connected with both stories. By means of this stove, Tom was able to keep the room warm during the coldest weather.

During Mr. Bronson's lifetime, various kinds of small hardware, pieces of steel, soft iron, brass tubing, panes or lights of glass, and various other odds and ends, had collected, which Mr. Bronson had stored away on shelves, or in drawers, arranged around the walls. Shortly before his death he requested that, as long as Tom lived with his mother, he should be permitted to have the use of this room, and of all his carpenter and lathe tools; and that the supplies were to remain in the work-shop for his use.

As soon as the boys reached the room, Tom opened the windows in order to cool off the air, for in Philadelphia, in the afternoon towards the end of a day in June, the weather is apt, at times, to be very hot. The wind, however, blowing freely through the three windows, soon cooled the room and the boys began to examine their penknives.

Placing a few wrought iron brads on the top of the carpenter's bench, they were pleased to find their knives had retained their magnetism; for, on opening one of the blades in each knife, they had no difficulty in picking up one of the brads from the bench.

"Look here, Tom," cried Rick excitedly, holding his knife in his hand with the brad attached to the blade. "The magnetism is strong enough to hold two brads one below the other." He then proved this by placing a second brad below the first, and gently letting go of it. The two brads held together, and slowly swung to-and-fro, being held to the point of the knife blade, and to each other, by the invisible force of magnetism.

Tom at once tried the same thing with his knife, and after some little trouble found that he was able to support three separate brads below one another. After this they tried experiments with brads of various sizes and also with some pins, of which Tom had a number in a pin cushion.

"Rick," said Tom, "I remember reading that a magnet can attract particles of iron through glass, paper, or wood. Let's see if our knives can do this." Getting a light or pane of glass from a box, he cleansed it, and supported it on two strips of wood so as to bring its lower surface near, but without touching, a number of brads and pins placed below it on a table.

On approaching the blades of their knives to the upper surface of the glass they found that the force of magnetism was able to act through the glass; for, as the knife blades were drawn across its upper surface, the pins and brads were lifted from the bench and clung to its under surface.

"Isn't it odd," remarked Rick, "that the magnetism can pass through a plate of glass?"

"It is, indeed," answered Tom. "I say, Rick, what queer stuff that magnetic flux must be. One can't see it, and yet it easily makes its way through the glass. I wonder if it can pass through two glass plates, placed over each other."

"Let's try," was the reply.

Cleaning a second plate Tom placed the two together when they found that the flux acted through both plates, attracting the brads and pins, though less strongly than through a single plate.

While they were thus experimenting, they heard a step on the outside stair-case. Soon a childish voice exclaimed:

"Brother Tom, may I come up and see you and Rick do tricks?"

"Yes, Jamie, come up. But don't call them tricks. Brother Tom and Rick are experimenting or investigating nature."

"Then Jamie wants to see you 'vestigate."

With this a small curly head was seen slowly mounting the steps. The head rose higher and higher on the steps and there came at last into the room a small boy about four years old. He had the same kind of curly hair and blue eyes as Tom, and, indeed, looked so much like Tom must have looked when younger, that almost any one would have known they were brothers.

"What's 'vestigatin', Tom? I thought you were doing tricks."

"Sit here, Jamie, and I'll show you," said Tom, placing a stool near the carpenter's bench so that the little fellow could easily see what was going on. He then removed one of the glass plates and made the brads and pins jump up from the bench and cling to the under surface of the glass plate, as he moved the knife blade over the upper surface.

Jamie was greatly interested, and said:

"You call that 'vestigatin', but I call it doin' tricks. Yes," he said, opening his eyes wider and wider, "and good tricks, too. Why don't the pins fall off the glass, Tom? I always thought that glass was slippery. Why do they stick to it?"

"It's the magnetism," said Tom.

"Magicism," said the youngster, not hearing distinctly. "I thought it must be, it's so queer."

"Jamie," said Rick, good-naturedly, handing him his penknife; "see if you can make the pins jump up from the table."

The youngster shouted with delight when he saw the pins jump up from the table and cling to the lower surface of the glass plate, as he drew the knife blade over the glass.

"Now, Jamie," said Rick, "you are investigating nature."

"No," said Jamie, stoutly, "I'm jess doin' tricks."

Removing the glass plate, Tom placed a quantity of iron filings on the table, and rubbing the knife blade over them, a fairly large quantity clung to the blade.

"Rick," remarked Tom, "one might easily pick pins and needles from the floor by means of a magnet. Let's make a pin and needle finder." Tying a piece of string to the middle of his knife handle, he was pleased to note that, on drawing it slowly over the floor, it picked up a pin, a small brad, and a quantity of iron filings, so that the invention of the pin and needle finder was a great success. Tom was a close observer. While drawing the knife over the floor, near the lathe, it passed over a mixture of iron and brass filings, and, of course, only picked up the iron filings.

"See how easy it is to separate iron from brass filings in this way," exclaimed Tom. "I have been wondering how I could get these iron filings out of the brass, placing a box containing a mixture of iron and brass filings on the table. Now I can easily do it," and plunging the knife blade into the mass he withdrew it, and then tapping it gently, found that the iron filings only remained clinging to its end. Wiping off the iron filings, he did the same thing several times, and soon had a fairly large pile of iron filings, while the mass in the box consisted of a larger proportion of brass.

"Great boy," said Rick, thinking the invention one of Tom's, "that's a good invention."

"Yes," replied Tom, "but it's not my invention. I remember now reading in several books about machines called magnetic separators. Mr. Edison has invented a number of these machines, employing them for the separation of small particles of rich magnetic sand from ordinary sand and earth. In these machines Mr. Edison employs powerful magnets something like the electromagnets we saw to-day on the Edison dynamos at the lighting station."

"I must go now, Tom," said Rick, "my supper will soon be ready, and I have been ready for it for the last hour. The walk has given me a good appetite. So good-bye, Tom."

"Won't you stay to supper with me?" asked Tom. "I know mother would like to have you. Come into the house a moment."

When they reached the house, Mrs. Bronson met them and invited Rick to stay to supper.

"We will have supper in a half hour," she said. "There will be plenty of time for you to run around to your house and let your mother know where you are."

"Do, Rick," said Tom, "I want to talk to you about some school matters."

"All right," replied Rick, "I'll run home and tell mother where I am. If she has nothing for me to do, and is willing, I'll come back in a little while. But, what's better, suppose you come with me, Tom?" he continued.

The boys went together to Rick's home, which was in the neighborhood. Rick's people were very wealthy, and lived in a much larger and finer house than the Bronsons. But Rick was not in the least spoiled by the fact that his father was rich, and that he was denied nothing, at least nothing in reason. He was just a hearty, healthy, happy boy, bright and full of fun, and yet capable of taking a deep interest in his studies—especially in his beloved chemistry—that would have been creditable to a much older lad. He thought the world of Tom, who was a favorite with the entire Justice family, especially with Rick's mother, who was only too glad to have her boy associate with such a clean-minded, manly young fellow.

After dinner the two boys spent some time in talking over the many things that had happened during that eventful Saturday.

VI.

THE ORAL COMPOSITION. A NOVEL LANGUAGE LESSON

Mr. Arthur Askinson, the principal of the grammar school, in which Tom and Rick were pupils, was an excellent teacher and succeeded in interesting the students in everything he taught. There is a study in the Philadelphia schools, that should be among the most interesting of all studies. This is what is generally known as "language." It is intended to teach the American boy or girl how to become familiar with the mother tongue. While in some schools this study holds its own with any of the other studies in exciting interest, yet in too many cases it is one of the bugbears of school life. This was not so in Mr. Askinson's school. He had worked hard in order to interest his pupils in "language." To this end he had them prepare compositions on various subjects, laboring hard to show them how to acquire the art of concisely and accurately expressing their thoughts in good English. To do this he endeavored to make them familiar with the language of the best English writers, by reading to them choice extracts from their books.

While he had made fair progress along both these lines, yet he was not entirely satisfied. He had, therefore, thought out a method by means of which, instead of having them prepare at home, a written composition describing some natural object, he planned to have the work done by each student in his presence and in the presence of the class, by having a spoken instead of a written description.

He expressed his wishes to the class on the Friday preceding the great baseball match as follows:

"I wish each of you to select some natural object of such a size that you can easily bring it into the schoolroom. Read up about this subject so as to be able to give an oral description of it. In other words, I want a brief lecture, or as it may be called an 'oral composition.' Now don't let the work frighten you because it is novel. I shall be satisfied if you do the best you can."

Quite naturally this unusual lesson made no little stir among the students. While they were, to a certain extent, tickled with the idea of being asked to lecture to their teacher and to the class, yet, at the same time, there was a certain awfulness in the word, 'lecture,' that frightened even some of the best of them. The new lesson, therefore, gave rise to considerable talk. Consequently, on Saturday night after the dinner at Tom's house, when Tom and Rick got through talking about the match and other events of the day, Tom said:

"Have you picked out the object you will describe in the language lesson, Rick?"

"Not yet. We have until next Tuesday to choose. I will try to take some interesting object, possibly something in chemistry. What are you going to choose, Tom?" enquired Rick. "But I hardly need ask. I am sure it will be something connected with electricity."

"You're right, Rick," said Tom. "I think I will take some pieces of electric light carbons for my subject."

There was much excitement among the pupils as the time set for the oral composition drew near. The novel character of the coming lesson greatly interested them, so that a more earnest study of natural objects was probably made for that lesson than had ever been made before.

In this way, the students learned much about natural science, not only while studying their own subjects, but also while listening to their classmates talking among themselves about the objects they had selected, or while they were endeavoring to obtain information concerning them.

The oral recitation was a grand success. The novelty of talking or lecturing soon wore off, and the students surprised themselves, Mr. Askinson, and their companions, by the clear manner in which they expressed their thoughts. Having thoroughly studied and read up all they could about the objects selected, they had no difficulty in telling about them in good, strong English, at least, English that might be fairly regarded as good, considering their ages.

A great variety of natural objects had been selected. Some brought food products, such as a lump of sugar, a few grains of rice, a few whole cloves, etc.; others brought such vegetables as potatoes, radishes, beets, etc. One boy brought a slice of bread, another a bottle of milk, another a bottle of ink. Having read up on all these things they were able to convey considerable information to the class in times varying from a quarter of a minute to three or four minutes.

Whenever, as, of course, sometimes happened, the statements made were inaccurate, the necessary corrections were at once made by Mr. Askinson. Whenever, however, he saw that some one in the class was able to make such corrections, he always let them do so.

Since we are especially interested in the oral compositions of Tom and Rick, we will give a fairly full description of what they said.

Tom had chosen, as he had told Rick he had intended to do, pieces of arc light carbons, for his subject. To many of the students these were strange and unknown objects, so that they listened intently to what Tom had to say about them. We will give a portion of Tom's remarks in full.

"I have in my hand," said Tom, "a small piece of carbon that has been used in one of the electric lamps employed for lighting the streets of our city. In these lamps, two carbon sticks or rods are placed one directly above the other. When the lamp is not lighted, and the electricity is not passing, the two carbons touch each other, but as soon as the electric current flows through the lamp an electro-magnet attracts a small piece of iron, thus drawing one of the two carbons a short distance from the other, when there appears between them a bright bow of flame, called an electric arc, which gives out a big light. The carbon rods used for this purpose are made of a kind of nearly pure carbon so hard that it is very difficult to cut or scratch them. I will try to cut one end of this piece of carbon with my penknife. As you see, I can hardly do so."

With this, Tom took out his pocket knife and opening one of the blades, endeavored to cut the carbon, to the great interest of his classmates, who eagerly watched him. It was, however, too hard to be readily cut.

"The other end of the carbon," Tom continued, "is soft and can be easily cut. The carbon arc is so hot that it easily fuses iron and other metals, not only melting them, but even making them pass off as smoke or vapor. This heat is so great that the ends of the carbons between which the arc is formed are changed into a soft material known as graphite, or black lead, the substance employed for making lead pencils. I will show to you that this end of the carbon rod has been changed to graphite; for, as you see, when I draw it over the sheet of paper I have pinned against the wall, it makes a black mark just like a lead pencil."

As Tom did this, a murmur of admiration broke out over the room.

"I have read," said Tom, "that at Niagara Falls, where they produce large quantities of electricity, many tons of graphite are manufactured every year by heating carbon to a high temperature by electricity.

"Here are several pieces of carbon that have been used in arc lamps," said Tom, taking some ten or twelve pieces of carbon from his pocket. "All have been changed at one end into graphite, and either have at one end a tiny hollow or crater, or a little hillock of soft carbon.

"The carbons with hollows or craters at their ends were the upper carbons in the arc lamps. When the two carbons are separated from each other, and the arc is formed between them, the electric current flows from one carbon through the arc to the other carbon. The carbon out from which the current flows, is called the positive carbon. The current flows out of the hollow at its end. This part is the hottest and therefore produces the greatest amount of light. For this reason, where the lamps are employed for lighting streets, the positive carbon is made the upper carbon, the greatest amount of its light being then thrown directly down on the street from the crater. The carbon boiled out of the opening in the crater, is slowly deposited on the surface of the other carbon, thus producing a small hillock or projection. In this manner you can tell by examining the piece of carbon taken from an arc lamp, whether it was the upper or the lower carbon. If you look for yourselves under almost any arc lamp, you may be able to find the bits of unused carbon that are thrown away, when the man comes around to place new carbons in the lamp."

When Tom stopped speaking, his classmates loudly applauded him, while Mr. Askinson said:

"Bronson, that was a capital oral composition. Now, Justice," he said, turning to Rick, "what object have you chosen?"

Rick took his place on the platform where all the students had given their talks, and spoke as follows:

"Last Saturday afternoon, I went with Tom Bronson to a big electric lighting station. While there, the chief electrician, Mr. Alexander, who had invited us to visit the station, showed us a number of wonderful things. When we were about leaving he magnetized our penknives by placing them against one of the sides of a big machine. He told us that if the blades were made of good steel they would keep their magnetism for a long time, or would not forget they had been magnetized. When we got back, I went with Tom into his laboratory. Here we tried a number of experiments with our magnetized knives. I will show you some of these experiments."

Rick then opened one of the blades of his knife, and placing a few pins and needles on the table, showed how the blade was able to draw and hold them to its end. This greatly interested the students, especially when he succeeded in suspending three needles one below the other at the end of the knife blade.

"It is curious," continued Rick, "that magnetism is able to pass through such hard things as plates of glass. If I rest this glass plate on the surface of these wooden strips, so as to raise it only a short distance above the table, and place the pins and needles under the glass, the magnetism in the knife blade is able, as you can see, to draw them towards it, and hold them on the under surface of the glass."

When Rick tried this experiment successfully, a loud applause from the students broke out all over the room.

"I will now show you," said Rick, "that it is possible to separate the iron filings from the brass filings in this tumbler. When I put the knife blade in the mixture only the iron filings are attracted to the blade. Mr. Thomas Edison has invented what he called a magnetic separator, that is employed for separating a sand-like magnetic iron ore from ordinary sand or earth."

When Rick completed his lecture or oral composition, he was also warmly applauded by the students. Mr. Askinson was much pleased and said:

"That was very good, Justice." Then turning to the class, he said:

"I am much pleased with the work all of you have done on your oral compositions. So much so, indeed, that instead of going on with the next lesson, I think I'll take that time to tell you a few things about some of the natural objects you have selected."

He then took one after another of the different articles that had, at his request, been left by each of the students on his desk after they had been described, and gave the class much additional information, thus greatly interesting the students.

"Don't teacher know a lot?" they said to one another.

After the completion of the general lecture, Mr. Askinson said:

"For our language lesson, for one week from to-day, I want each of you to read up on the subject of the Leyden jar. I will call on each of you to give, in the way of an oral composition, or lecture, any information you may have obtained on this subject. I think you will have no difficulty in finding books in the public libraries that will tell you about the piece of electrical apparatus called the Leyden jar, how it was discovered, and what it is capable of doing.”

As the students left the school that afternoon, they all agreed that language, as taught by Mr. Askinson, was indeed a most interesting subject.

“Tom,” said Rick, in his joking way. “One of the boys asked me the following conundrum: ‘What is the name of that school subject which begins with an “l” and ends with an “e” and has an “ng” between the first and the last letters, the ‘ng” standing for “no good.” I guessed language at once, but told him that n.g. did not stand for no good, for I thought language a very good subject, and, is more and more interesting as I study it. Indeed, I think the n. g. stands for ‘nothing greater.’ ”

VII.

THE LEYDEN JAR AS AN ORAL COMPOSITION

When, at the close of the language lesson, Mr. Askinson announced the Leyden jar as the subject for the next oral composition, Rick winked at Tom, showing by the expression of his face how much this subject pleased him, for the Leyden jar was a piece of electric apparatus about which both he and Tom had not only read, but with which they had also tried many experiments.

As soon as the school was dismissed and they could talk freely, Rick said to Tom as they walked home:

"That's an all right subject for the next oral composition. We can get a lot of information about it."

"A capital subject. Rick, we had better go at once to the public library and get out some books on electricity. Since Mr. Askinson told the class that they could get books there, many will probably go there. If we don't go there soon we'll get left."

"Then let's go at once," replied Rick.

On reaching the library, and asking for books on the Leyden jar, the librarian who knew Tom said to him:

"I think one of the best early books on this subject is Cavallo's. It is somewhat rare and is not given out except to careful readers. I know, however, that you take good care of books, so I will let you have it."

Tom thanked the librarian and took the book. Rick selected a more modern book, "Parke Benjamin's Intellectual Rise of Electricity." As the boys were about to leave the librarian said:

"You had better look also through the encyclopædias. They all contain something on the Leyden jar. As encyclopædias are books of reference, they cannot be taken out of the library, but you can sit at one of the tables and make notes from them."

As they turned to leave the librarian several of their classmates came up and asked for the best books they had on the Leyden jar.

"I have just given out the two best books on the early history of this subject," said the librarian, "to these lads," pointing to Tom and Rick. On hearing this the boys laughed and one of them, turning to Tom, said:

"We'll have to get up early to get ahead of you, Tom. I say," he continued, "isn't that an all right way Mr. Askinson is teaching us language? I'm going to read a lot about the Leyden jar."

After leaving the library, the two boys went to Tom's laboratory where they began looking over their books. Tom's book, which was in three volumes, was called, "A Complete Treatise on Electricity in Theory and Practice," by Tiberius Cavallo, F.R.S.

"What does that F.R.S. mean, Tom?" asked Rick, who was looking over Tom's shoulders as he was reading the title page of the book.

"It stands for Fellow of the Royal Society? Hello!" he exclaimed, as he continued reading the book, "look, Rick," he said, pointing to the bottom of the page, "it is quite an old book. It was printed in London in 1795. I hope it will tell me something about the history of the Leyden jar."

Both boys began looking over their books and occasionally talking, for about fifteen minutes, when Rick said:

"Tom, tell me something about the Leyden jar. You know more about it than I do. I will then be better able to understand my book."

"All right," said Tom, "I'll tell you what I remember. The invention of the Leyden jar was made about the year 1745, by a man named Von Kleist, Bishop of Pomerania, a province of Prussia, on the shores of the Baltic. In order the better to understand Von Kleist's discovery, let's examine this Leyden jar you and I have used so often."

With this Tom took up an ordinary Leyden jar and said to Rick:

"You see, there are two coatings of tin foil placed opposite each other on the outside and inside of an ordinary glass jar. The coatings cover the bottom and a portion of the sides of the jar, both inside and outside. They do not, however, reach to the top. If they did their charges might leak over the edges and so empty the jar. The inside coating is connected at the top of the jar to a smooth brass ball by a metallic wire passing through a cork in the mouth on the jar. To discharge the jar it is only necessary to touch both the outside and the inside coatings at the same time.

"Like many learned men who came after him, Bishop Von Kleist was anxious to find out more concerning the strange force of electricity. He thought that if he could collect a quantity of electricity in a small space, he might be able to study it better. Remembering that electricity cannot easily pass through glass, Von Kleist thought that if he let electricity run in a glass bottle he might be able to fill the bottle. To do this, he placed some water in a small bottle, and carefully hung a bent wire on an electrical machine, and holding the bottle in his left hand, pushed its open mouth upwards so that the lower end of the wire touched the water. Then, when an assistant turned an electrical machine, the electricity flowed through the wire into the water in the bottle until he thought it should be full."

"Wait a moment," said Rick, interrupting him, "here's a picture in the book I was looking at that represents Von Kleist discovering the Leyden jar."

"Let me see," said Tom. "Yes," he remarked after examining it, "that's the way Von Kleist made the discovery."

"Did he get his bottle full of electricity, Tom?"

"You bet he did," said Tom, laughing. "He collected so much that when he attempted to take the bottle off the machine, he was both surprised and frightened at the unexpected shaking he received. His left hand, in which the bottom of the jar was held, formed the outer coating and the water inside the bottle the inner coating of a Leyden jar, so that as soon as he brought his right hand in contact with the conducting wire, the two coatings were discharged through his body from hand to hand. He declared that this shock was strong enough to stun both arms and shoulders."

"This will make a good story for the oral composition," remarked Rick.

"It will," replied Tom, "if some of the others who speak before we do don't use it. The one who speaks last may have much trouble in telling anything new. We must, therefore, read up a lot about the Leyden jar, so that there will be something new to talk about when our turn comes."

"Tom," enquired Rick, who had been thinking, "why is this called a Leyden jar? Leyden was a city of Holland and not of Pomerania, where you say Von Kleist lived."

"You're right, Rick," answered Tom. "Some say this invention was made by a man named Cuneus, a pupil of Prof. Muschenbroeck, of Leyden, and others say Muschenbroeck himself made it. It seems that Cuneus and Muschenbroeck were the first to bring the jar to the attention of the world, so that it became known as the Leyden jar, the name still given to it."

"I'll bet Muschenbroeck and the others were surprised when they first received the discharge of the jar," said Rick.

"They were, indeed, Rick," said Tom, laughing. "I remember reading a description Muschenbroeck gave of the first shock he received. He declares he was struck in the arms, shoulders, and breast, so hard that he lost his breath, and did not recover from the effects of the blow and the terror for ten whole days, adding: 'That he would not take a second shock for the Kingdom of France.'

"Another man describing the first shock taken from a comparatively small jar, said:

"'That he lost his breath for some minutes, and then followed so intense a pain along the right arm, that he feared permanent injury therefrom.'"

"Tom," enquired Rick, "do you believe these shocks were so strong? It don't seem to me that any of these early jars could have given a very powerful shock. You and I have often taken shocks from jars that were probably much larger than those used by either Cuneus or Muschenbroeck."

"I guess you're right, Rick. The accounts of the effects produced were probably greatly exaggerated. Indeed, I understand, from what I have read, that Muschenbroeck, although he declares that he would not take another shock for the Kingdom of France, yet after his

LOOK AT THE FUNNY PICTURE THERE IS IN THIS BOOK

first experiment, spent much of his time in either taking shocks himself, or in persuading his visitors to take them. Of course, Rick," he continued, "we must remember that so very little was known in those early days about electricity, that the shock of the Leyden jar, coming, as it did, so unexpectedly, led them to exaggerate its effects."

"Then these men were batting them out." Batting them out means, as all boys know, 'drawing the long bow,' 'stretching it,' or exaggerating.

"Yes," said Tom, laughing, "I guess that's about the size of it."

There was silence in the room for the next five minutes. Both boys became interested in their books. Now, five minutes silence between two lively boys at full liberty to speak when they wanted to, was probably the limit. Rick broke the silence exclaiming:

"Look here at the funny picture there is in this book, Tom. A number of well dressed men and women are doing something strange to a boy who is hanging from cords fastened to the ceiling of the room. What are they doing to the boy, anyhow?"

"Let's see it," said Tom. Examining it carefully, he said: "Here is a description of the picture in your book. At the time of the discovery of the Leyden jar it was fashionable for the lords and ladies of the French court to visit the laboratories of scientific men in order to see experiments in electricity. The boy, in the picture, is hung from the ceiling of the laboratory by four strong silken cords, so that when the man, who has a glass rod in his hand that he has electrified by rubbing, touches the boy and thus fills him with electricity, it can't escape to the floor or the ceiling."

"Hello, Tom," said Rick, "what's that lady doing who is holding her finger to the boy's nose?"

"Drawing electric sparks from it, Rick."

"Oh, I know, just as you did the other day, when I stood on an insulating stool, and you sent electricity into my body from your frictional machine." He then added, looking at the picture: "What are those balls over which the boy is holding his hand?"

"Balls made of pith, the white stuff found inside stalks of the elderberry and other plants. I have some pith balls here," said Tom, going to a drawer, and taking some very light white balls from it, and placing them on the table. He then took a rod of glass and rubbing it briskly with a piece of cat's fur, so as to electrify it, he held the rubbed glass near the pith balls. They were at once attracted or drawn towards the glass, and, then, after clinging to its surface for a few minutes, were thrown violently off. The power of the rod to shoot off the balls was so great, in some cases, that they were thrown considerable distances through the air.

"This experiment would succeed much better," said Tom, "if tried during cold weather, when the air is dry. Now, there is so much moisture in the air that the rubbed glass rapidly loses its electricity."

There was again a shorter period of silence, lasting this time for only two minutes, when Tom, looking up from Cavallo's book, cried out:

"I say, Rick, they appear to think that the discovery of the Leyden jar was very wonderful. Listen to what Cavallo says about it:

"'Nothing contributed to make electricity the subject of public attention, and excite a general curiosity, until the capital discovery of the vast accumulation of its power in what is commonly known as the Leyden phial, which was accidently discovered in the memorable year, 1745. Then and not till then, the study of electricity became general, surprised every beholder, and invited to the houses of electricians a greater number of spectators, than were before assembled together to observe any philosophical experiments whatsoever.'

"Since the time of this discovery, the prodigious number of electricians, experiments, and new facts that have been daily produced from every corner of Europe, and other parts of the world, is almost incredible. Discoveries crowded upon discoveries, improvements upon improvements; and the science ever since that time went on with so rapid a course, and is now spreading so amazingly fast, that it seems as if the subject would soon be exhausted, and electricians arrive at the end of their researches. But, however, the *ne plus ultra* is, in all probability, as yet at a great distance, and the young electrician has a vast field before him, highly deserving of his attention, and promising further discoveries, perhaps equally or more important than those already made.'"

When Rick heard this, he began laughing, and said:

"They were very much stuck on themselves. Just think of what an immense number of things has been discovered in electricity since that time."

"Yes," replied Tom. "What they knew then as compared with what is now known, was about like a drop of water in a bucket full of water."

"What does *ne plus ultra* mean, Tom?"

"It means, the limit, or nothing beyond. They thought they had gone so far forward in electrical discoveries that they could not possibly go any further."

The boys continued reading and talking until near supper time.

Both Tom and Rick, in common with their classmates, spent much of their time in reading in different books about the Leyden jar. During several afternoons in the week they visited one of the libraries. Here the librarian kindly brought them different encyclopædias and other books from which they were able to obtain many interesting facts concerning the Leyden jar and the Leyden-jar battery, the name given to a combination of a number of separate Leyden jars connected so as to permit them to be used in a single large jar.

But, perhaps, the book which gave Tom as much information as any, concerning Leyden jars, was an autobiography of Benjamin Franklin.

Here, Tom found that in 1747, or about two years after the discovery of the Leyden jar, contrary to what was then generally believed, Franklin proved that the electricity does not remain on the metallic coatings of a charged jar, but collects on the opposite sides of the glass. Franklin made a jar he called a 'dissected jar,' in which the coatings might be easily separated from the glass, so that after the jar was charged, the inner and outer coatings could be removed, and touched by the hand, or to each other and that when the coatings were replaced on the glass jar, even if they had been off from it for four or five minutes, a powerful discharge could then be obtained.

This description interested Tom so much that he determined to make a dissected Leyden jar. He did this and the jar worked so well that he concluded to exhibit it at the approaching oral composition.

Rick, who had also been reading Franklin's book, succeeded with the help of Tom, in making a few pieces of electric apparatus that he concluded to exhibit before the school.

When the class in language met at the grammar school on the day appointed, Mr. Askinson said:

"In order to be fair, I shall call on you by lot; for, of course, those called first will have a better opportunity of describing novel matters to their classmates than those called last. Now," he said, "there are thirty students in this class, so I have written on these thirty pieces of paper, numbers from one to thirty. I will put these pieces of paper in a bag, shake them up, and will ask each member of the class to come rapidly to the platform and take one of the pieces of paper from the bag."

As soon as this was done, he said:

"I have another set of papers, similarly marked from one to thirty, which I will put in the same bag, and thoroughly shake them up." Then calling the youngest boy in the class he had him put his hand in the bag and draw from it one piece of paper at a time. As each piece was drawn the number was called, and the student holding this number went to the platform to tell what he knew concerning the Leyden jar.

The above method, being perfectly fair, greatly pleased the class.

The exercise was another great success. The members of the class had collected various items of information concerning the Leyden jar. When Tom was called, he described his dissected Leyden jar. He said in part:

"Benjamin Franklin was a Philadelphia printer, who lived a long while ago. He was the man who first drew lightning down from the clouds, and proved that it was electricity. He invented the lightning rod, by which buildings can be protected from destruction by lightning. Franklin made a great many interesting experiments with the Leyden jar. Among other things, he made a form of Leyden jar, by means of which he was able to prove that in a charged jar the electricity does not remain on the pieces of tin foil on the inside and the outside of the jar, but on the opposite sides of the glass.

"Here is a dissected Leyden jar," said Tom, "that I have made. It consists, as you see, of three parts—a wide-mouthed glass jar; a shorter metallic jar, large enough to permit the glass jar to rest in it; and another metallic jar, small enough to go inside the glass jar."

Tom then exhibited his dissected jar and after charging it, from an electrical machine Mr. Askinson had placed on the table, removed the inner and outer coatings, touched them with his hand, and brought them together repeatedly. Then replacing them on the jar, he persuaded one of the boys to touch the outside and inside coatings at the same time in order to see if the jar was still charged. The boy did this, and to his great surprise received a shock, that greatly delighted his classmates.

There was great fun when Rick was called on and showed some experiments with the apparatus he had made.

He had mounted a small bell on the upright rod, connected to the inner coating of a Leyden jar, and had another bell supported on a metallic rod placed upright on the table. This rod extended above the bell and was bent near the top so as to support a small brass clapper hung by a silk thread. The length of the thread was such that the clapper was at the same distance above the table as the bell. Placing a small strip of tin foil on the table, so that it came in contact with the metallic rod, he now put a charged Leyden jar on the table, so that its outer coating rested on the strip of tin foil, and at such a distance from the upright rod that the suspended brass clapper hung exactly midway between the two bells. Slightly moving the silk thread towards the Leyden jar the clapper was instantly attracted to the bell, striking it sharply and ringing it, and was then immediately repelled or thrown from it towards the other bell, striking

IMMEDIATELY THE SPIDER ACTED AS THOUGH ENDOWED WITH LIFE

and sounding it. These movements were kept up for some time, producing a rapid succession of sounds that greatly pleased his audience.

"I will now show you," said Rick, "how Benjamin Franklin, of whom Tom has been talking, modified this experiment."

He then showed them an experiment that especially pleased his audience. He had cut a small piece of pith so as to resemble the body of a spider, and had blackened it with ink, placing two little pieces of white paper on opposite sides of its head for eyes. He had furnished the body with legs consisting of pieces of black linen thread, and, weighting the body with a bit of lead, so as to keep the head upwards, he removed the brass clapper from the silk thread and replaced it by the pith spider, again charging the Leyden jar and placing it on the table.

Immediately the spider acted as though endowed with life by the potent power of electricity; for, it appeared to jump deliberately to the bell connected with the Leyden jar, at the same time bringing all its eight legs in contact with the bell, as if trying its best to hold on. Almost immediately, however, as if the Leyden jar was too warm, the spider jumped with great speed to the opposite bell, to which it also clung by its eight legs. It apparently did not find this resting place any more pleasant than the other; for, it immediately jumped back again to the Leyden jar, remaining, however, on it but a few seconds, and keeping up these movements continually. It particularly pleased the class to see the rapidity with which the spider jumped from bell to bell, and especially its great skill as a gymnast; for, it always landed squarely on one or the other of the two bells; and no matter how often it jumped from one to the other, it never missed.

As soon as the last student had been called on to tell about what he had read about the Leyden jar, Mr. Askinson, in order to impress on them the nature of the shock caused by discharging a Leyden jar through the body, asked all the students to join hands so as to form a continuous line, the two ends of which were only a few feet apart. Then charging a small jar at the machine, he held it in his hand, and asked the boy at one end of the line to place his hand on the outer coating. He then said:

"You are now all connected through your bodies with the outer coating of the Leyden jar. As soon as the boy at the other end of the line touches the knob of the jar with his finger, a discharge will take place through your bodies, giving you a shock. It will not be a very severe shock, since I have used a small jar and have not put much of a charge in it. Now, I want you to watch the boy when he puts his hand on the knob, and see how many times you can say, 'Jack Robinson,' before you feel the shock."

"We will catch teacher there," whispered several of the students, especially those near the middle of the line. "We ought to be able to say 'Jack Robinson' several times before we feel the shock." So keeping their eyes on the boy, they got ready to begin saying 'Jack Robinson.' But it was a race against electricity; before they could even begin to pronounce the first syllable of Jack's name, all felt the shock.

Some were greatly frightened and imagined they had been badly hurt. But in a few seconds, finding that nothing serious occurred, all began to laugh and begged Mr. Askinson to send a stronger discharge through them.

But what pleased the students most of all was when Mr. Askinson showed them how they could make a Leyden jar for themselves, by getting any wide-mouthed jar or bottle, and pasting pieces of tin foil, such as come wrapped around cakes of sweet chocolate, over the inside and outside a few inches from the top. He showed them how easy it is to smooth out the wrinkles in one of these sheets by placing it against the window pane and rubbing a blunt surface such as the nail of the thumb over it. He then told them, how, in order to bring the inner coating near to the outside of the jar, they could stick a piece of copper wire through a cork fitted into the open mouth of the jar, and cover the edges and top of the cork with sealing wax.

"What will probably bother you most," he said, "will be to provide the upper end of this wire with a smooth button or ball. If you get a smooth, round, metallic button and ask a tinsmith to solder it to the wire, it will answer very well."

He then dismissed the class, saying:

"Instead of another oral composition on electricity for our language lesson next Thursday, I wish all of you to make Leyden jars and bring them to the school on that day, when I will charge them from our machine and we will see how they work. Those who are unable to make jars must read up on some subject in electricity and come ready to talk about it."

VIII.

THE SECRET SOCIETY OF THE JOLLY PHILOSOPHERS

We must again warn our readers that if they are beginning to look on Tom and Rick as boys of the unnatural type of premature old men, they are greatly mistaken. Both boys, especially Rick, were full of fun and pranks, and greatly delighted in playing jokes on each other and on their classmates. Nor were these jokes generally resented by their victims. As a rule, they were good-natured, and so appealed to the boy's sense of humor that they were soon forgiven though not often forgotten until repaid with interest.

Tom and Rick had organized among a few of the boys, a secret society known as "The Jolly Philosophers." The name of the society will give a good idea of its general scope, since it was formed for the purpose of having instruction, as well as fun and merriment, along scientific lines.

The Jolly Philosophers met every Friday evening in Tom's laboratory, which was large enough to comfortably accommodate ten or twelve boys, or even a somewhat larger number when sitting close together. Several gas brackets in the room permitted it to be well lighted at night.

By the rules of the society, each member was expected once every month either to read a short paper, or to make a few remarks on something in Natural Philosophy, or Chemistry. Criticisms or remarks by all the members on such papers were especially encouraged. Wherever possible, the papers or remarks were illustrated by experiments that were more or less scientific, according to the ability of the writer or speaker. In this way, the members had excellent training in what should constitute the highest type of education; *i.e.,* the ability to think while standing before an audience, and at the same time to express one's thoughts correctly and concisely.

It was an unwritten law of the Society that when the more serious business of the meeting was over, tricks or jokes on one another, especially of a scientific character, were both permitted and encouraged. Consequently, after meeting together, and learning no little about physical science by an interchange of thoughts, they were sure of a jolly time before dismissing for the evening.

Entrance to the Society was by secret ballot. As its membership was necessarily limited by the size of the room, a single black ball rejected a candidate.

There had been much talk among Tom and Rick's classmates about the Society of the Jolly Philosophers. As it was generally known that its members had much fun at the latter part of the meeting, there were more applicants for membership than could possibly be admitted, so that, whenever a vacancy occurred, there was a rush to become a member. All candidates were required to appear before a committee known as the "Membership Committee," whose duty was to discuss the general character of the applicant. If anything objectionable was known, his name was not permitted to come up for election. And even if it should pass this committee and thus come up for a vote, a single black ball would exclude the candidate.

At this time the membership committee consisted of Tom, Rick, and Sandy Jamieson. Both A. Phineas Skinner and Ralph Coffin had applied for membership. It was Thursday afternoon, just one day before the regular meeting. The membership committee had met in the laboratory to discuss the applications of the candidates. There was only one vacancy, so that but one of the applicants could be elected.

When Skinner's name came up for consideration, Sandy was very much opposed to him. Skinner had on several occasions shown great contempt for the Scotch lad.

"I winna vote for the lad," he said. "In my opeenion he is a ne'er do well."

"I don't think much of the fellow myself," said Rick. "Even if we recommend him I don't believe the boys would let him go through without a black ball. What do you say, Tom?" he asked.

"According to our rules," replied Tom, "Skinner will come to see us this afternoon. We can then question him. Suppose we wait until he meets us. Besides being proud, I understand that he is very inquisitive. Now, suppose we give him a test. When he comes here we will leave this large closed book on the table," pointing to a book that neither Rick nor Sandy had ever seen before, and which, although they were tempted to examine it, knowing that Tom was up to jokes, and fearing he had placed it there in order to trick them, had been careful not to touch it. "We will warn him not to open the book, since it contains secrets of our Society, that we especially wish to guard. After making him solemnly promise not to touch the book, we will leave the room for five minutes. If he keeps his promise, and does not open the book, I am willing that we let his name come before the Society, leaving it to the boys to determine whether to admit him or not."

"But how can we tell if he touches the book?" enquired Rick.

"There will be no difficulty about that," replied Tom, laughing. "If Skinner opens the book he will tell us himself about it."

"How will you do this, Tom?" enquired Rick, for he knew that his friend was very clever in setting traps for boys like Skinner.

"Excuse me, Rick," said Tom, laughing. "This is a new trick. I will explain it to you afterwards. I will, therefore, ask both of you to leave me alone in the room for a few minutes while I fix the book."

Pleased to know that some good trick was to be played on Skinner, and a trap set for him, the boys willingly left the room, remaining out until Tom called them about five minutes afterwards.

"Now," he said, laughing, "be careful that neither of you touch the book."

"You needn't be afraid of my touching it," said Rick, as he carefully examined, without coming near, the large ponderous book as it lay on the table.

"I'll nae touch it," said Sandy, grinning. "It's an uncoo looking book."

Steps were now heard ascending the stair-case. A knock was soon heard at the door, which the committee had purposely locked.

"Who comes there?" asked Tom.

"A. Phineas Skinner," was the reply.

"What does A. Phineas Skinner want?" enquired Tom.

"I have made up my mind to join the Society of the Jolly Philosophers," was the reply.

"Made up his mind to join us, has he," said Rick in a low tone. "Just like his impertinence."

"Enter, A. Phineas Skinner," said Tom, going to the door and unlocking it, "and answer the questions the Membership Committee put to you."

So Skinner came into the room with his cap still on his head.

"Remove your cap, sir," said Tom, sternly.

When Skinner did this, Tom enquired:

"You ask to be admitted to the Secret Society of the Jolly Philosophers?"

"Yes," replied Skinner, "I may as well join your Society."

"Will you solemnly promise to obey its rules and regulations, and never to divulge its secrets?"

"Of course, I'll promise," replied Skinner in a disagreeable tone. "If I am willing to join your Society, I expect to obey its rules, and am not such an idiot as to go around blabbing its secrets to everybody."

"Skinner," said Tom, "we ask that you remain in this room by yourself for ten minutes, and think carefully over what it means to join a secret society like that of the Jolly Philosophers. If admitted, should you afterwards be so unfortunate as to disclose any of its secrets, I shudder when I think of what might happen to you. I have read of people disappearing and of never again being seen, for disclosing the secrets of societies like ours. I, therefore, warn you not to join us unless you are sure you can guard our secrets as you would your life."

A. Phineas Skinner was evidently much impressed with the solemn manner with which Tom had been speaking.

"Are you ready to make the trial, Skinner?" asked Tom in a solemn manner, after a short silence.

"I am ready," said Skinner.

"Will you promise?" continued Tom, "not to touch or open the book you see lying on the table there? It contains some of our most important secrets. It would injure our Society and give anyone who might read it an undue power over us."

"I promise," said Skinner, "not to touch or open the book."

But Tom saw by the expression on Skinner's face that he had determined to avail himself of the opportunity thus offered of learning such secrets as would place the members of the Society at his mercy.

"Then," said Tom, "we will leave you here to think over the matter and determine whether you still wish to join us. Remember you are taking a great responsibility on yourself." With that he and the other two boys went out of the room leaving Skinner by himself.

Without attempting to listen at the door, the committee descended the stair-case into the street and waited a short distance from it. In about five minutes, a yell of terror was heard from the laboratory. The door was suddenly burst open, and Skinner appeared at the top of the staircase, his face blanched with fear as he cried out to the boys:

"Help! help! I have been injured by an explosion."

The two boys looked anxiously at Tom, who only laughed and said:

"Skinner has broken his promise, and has tried to read what he thought was in the book. Don't worry yourselves, he is more scared than hurt. He has been punished for attempting to learn our secrets."

As the boys ascended the stair-case, Skinner, seeing that no serious effects resulted from the severe shock he had sustained, went back into the laboratory, followed by the committee.

"Skinner," said Tom, "you have broken your promise and opened the secret book of our Society. What have you to say for yourself?"

Surprised by Tom's accusation, Skinner had recourse to a lie, and said:

"That's not so. I did not open the book. A fly lighted on it, and I simply tried to drive it away, when I received a shock like a lightning flash, and at the same time heard an explosion like the noise of a gun."

Tom now closely examined the book, and said to Skinner:

"You must have moved the book from the table; for, it is now in a different position than it was when we left the room. Skinner, you have broken your promise, and cannot join our Society."

"I don't want to join your old Society," said Skinner viciously. "I see now you laid a trap for me."

"But," said Tom, "unless you had broken your promise, you would have received no shock. Good-day," he said, "we will not keep you here any longer."

Having thus disposed of Skinner's application for membership, the committee now took up the application of Ralph Coffin; who came to the laboratory shortly after Skinner left. After discussing his case and talking with the applicant, it was unanimously agreed to permit his name to come before the Society for election. It may be mentioned here that he was elected unanimously. Indeed, it seldom happened, after the candidate was favorably reported on by the committee, that he failed to be elected.

When Ralph left the room, Rick said to Tom:

"Now explain this trick to us, as you promised you would. It is certainly a splendid one."

"All right," said Tom, "but you must promise not to say anything about it to the other boys, as I want to have some fun at our next meeting night."

"We promise," said the boys, anxious to learn the trick.

Tom then explained the manner in which he had placed a large Leyden-jar battery inside the covers of what closely resembled a book. The battery was formed of a number of plates of tin foil attached to opposite sides of much larger sheets of paraffine paper, and so connected with one another as to form a single large jar. Tom had so constructed the cover of the book that any one attempting to read it would bring one of his hands in contact with one of the coatings of the jar, while raising the book from the table, and the other hand in contact with the other coating, while attempting to open the book, thus discharging the jar through his body.

"Tom," enquired Rick, "how long will such a Leyden-jar battery remain charged?"

"When properly made," replied Tom, "it will keep its charge for several hours; or, indeed, for many days. At first I was unable to make a jar that would hold its charge for longer than ten or fifteen minutes. At last, however, by using sheets of paper free from pin holes, and pasting two such sheets together, so that even if any holes were present, they would not be apt to come together on the same part of each sheet, I obtained sheets that when thoroughly soaked in melted paraffine, would produce a jar that would retain its charge for a much longer time."

IX.

RALPH COFFIN'S INITIATION TO THE SOCIETY OF THE JOLLY PHILOSOPHERS

At the regular meeting of the Secret Society of the Jolly Philosophers, held the next Friday, the favorable report of the Membership Committee, nominating Ralph, was made in due order of business, and on a vote being taken, the candidate was unanimously elected.

In accordance with the rules of the Society, Ralph, in company with a Committee appointed for that purpose, waited outside the door, to learn the result of the election. Tom, who was President of the Society, and who was especially pleased at the election, for he recognized Ralph as an unusually able boy, stepped outside for a moment to tell him the result of the election, and to congratulate him.

"While you have been elected a member of our Society, Ralph," he said, "you will not really be one of us until you have been initiated. Please wait outside with the Committee while we prepare the room for the initiation."

"All right," said Ralph, laughing, "don't kill me."

Tom looked at Ralph with a solemn face, and remarked:

"Ralph, the initiation into our Society is fierce." And then seeing that Ralph was a little scared, reassured him by a smiling wink.

On returning to the room, Tom exclaimed:

"The initiation committee will now get the room ready for the initiation of a new member."

A great stir at once began. One member spread a black cloth over a table before which the President was to sit. Another brought out a human skull and two leg bones, Tom had obtained from students in one of the great medical colleges in the city. Placing the skull on the table and crossing the two bones over each other, he placed them below the skull. Another member brought out two large daggers and a bare sword, and placed them on the table alongside the skull and crossbones. The members then put on gowns of black muslin while one of them dressed himself in a tightly fitting suit of black, on which strips of white cloth had been sewed, so as to make him, when the lights were turned down, resemble a living skeleton. When he danced in a horrible manner on the floor of the room, at some distance from the table, one not knowing the secret of his dress, might readily take him for a visitor from the grave, come to see how the Jolly Philosophers initiated their members. In the meantime, Tom had dressed himself like an old man, covering his face with a gray beard, and moustache, and assuming the bent attitude characteristic of old age.

"Take your places," said Tom, "and bid the committee who are waiting outside to bring in the candidate."

A loud knocking was now heard at the outer door.

"Door-keeper," said Tom, "who knocks?"

"Who knocks at the door of the Ancient and Honorable Society of the Jolly Philosophers?" enquired the door-keeper. (N.B., in point of fact, the aforesaid Ancient and Honorable Society had only been in existence for some two months; but it sounded so much better to call it Ancient and Honorable, that they humorously employed these words.)

A voice was now heard from the outside.

"A stranger who asks to be admitted to the Society."

"Have you examined the stranger," asked the door-keeper, "and are you convinced that he is fit to be admitted?"

"We have," replied the voice, "and we find him worthy of admittance to our order."

"Bid the stranger enter," said Tom.

The door-keeper opening the door, Ralph, blindfolded by means of a handkerchief bound tightly over his eyes, was led into the room by the committee.

"Do you wish to join the Ancient and Honorable Society of the Jolly Philosophers?" questioned Tom.

"I do," replied the candidate.

"Are you willing to sign its constitution, and promise to obey its laws in all things?"

"I am."

"Then remove the bandage from his eyes," ordered Tom.

When the handkerchief was removed from Ralph's eyes a strange sight was disclosed. Instead of seeing Tom sitting in the President's chair, as he had expected, there was a venerable old man, with snow-white hair and long white beard, sitting before a table containing the skull and crossbones, and the naked sword and daggers. In place of the boy members of the Society, he saw forms clad in black gowns with masks over their eyes. In order to make their appearance all the more horrible, Rick had placed on the table a lamp which emitted a yellowish flame only. This gave the portions of their faces not covered by the masks the appearance of corpses.

Tom, or rather, the old man, now addressed Ralph in a solemn voice and said:

"Stranger, you who seek admission to our Society, must take the following oath: 'I, Ralph Coffin, do solemnly swear that I will never, while a member of this Society, or afterwards, reveal any of its secrets, but will carefully guard the same. If I should break my oath, I must expect severe punishment.' "

Ralph now took the oath and Tom then addressed him in a solemn manner and said:

" Having been initiated you are now a member of the Ancient and Honorable Society of the Jolly Philosophers. Guard its secrets as you would your life. The skull and crossbones you see were once parts of a living body. Beware how you speak of what takes place here! Either by the naked sword, or by the drawn daggers, or by other means the Society may select, you could easily be made like this skull and these bones, devoid of life. See," he added, pointing to the dancing skeleton, " the grave opens, and one of the dead comes out to bid you welcome should you betray our secrets." At this the living skeleton began to dance and grin in a horrible manner.

" Are you ready to pledge me in a goblet of good clear water, to guard our secrets? "

" I am."

When Tom called out in a loud tone:

" What ho there! Bring me two goblets of pure water, with which to pledge our new member," then turning to Ralph he added:

" Brother, I drink your health in this goblet. Will you drink to the health of our order? "

Ralph nodded and took the goblet, but when he raised it to his lips, he received a severe shock, for the goblet consisted of an artfully constructed Leyden jar, arranged so that its outer coating was brought into contact with Ralph's hand as he held it, while its inner coating or water was brought into contact with his lips, as soon as he had commenced to drink. The shock was fairly severe, but Ralph succeeded in keeping his hold on the goblet, and continued drinking until he had completely emptied it.

"Brother," said Tom, "you stand the test well. You are now one of us." Then turning to the committee, Tom said: "Take our new member outside the room while we make ready for his reception."

In about five minutes, Ralph was again admitted to the room. The skull and crossbones, together with the drawn sword and daggers and the black cloth, were taken off the table, and the strange dresses removed, so that Ralph saw and recognized his boy friends and fellow-members.

As Ralph approached the President's chair, Tom arose and said:

"I welcome you as a member of the Ancient and Honorable Society of the Jolly Philosophers. I will now ask you to sign the constitution," he remarked, pointing to the same book that had been employed to give Skinner such a severe shock, but now containing a smaller charge.

As Ralph opened the book he saw on the first page, a copy of the constitution and by-laws of the Society that had been signed by all the other members. He picked up a pen, but before he could dip it in the ink he received a shock; for, he had thus discharged the Leyden-jar battery through his body. Although the shock was severe, he had sufficient grit to keep hold of the pen, and sign his name underneath one of the other names.

The boys, admiring the pluck of the new member, applauded him, and collecting around him shook him by the hand and welcomed him to the Society, saying:

"You are one of us, now, Ralph. We hope you will have a jolly time with us. What do you think of our initiation?"

"It's all right," replied Ralph, laughing. "But I think I shall enjoy it more, when, as one of the members of the Society, I take my part in initiating the next new member."

The officers of the Society consisted of a President, Vice-President, Secretary, and Treasurer, together with various standing committees, such as the House Committee, Entertainment Committee, Membership Committee, etc. As soon as the regular routine business had been completed, which on account of the initiation had been purposely short, Rick went to Tom, and leaning over him, whispered something in his ear. Tom nodded his head, and smilingly replied:

"The idea is a capital one, suppose you try it."

Then calling the meeting to order, he asked Ralph to come up to the desk, and addressing him, said:

"It is our custom at the close of the regular business of the Society to play our part as Jolly Philosophers, and have a pleasant time together. But before doing this I wish to ask you a question. I have been informed that you are an inveterate smoker of cigarettes." (N.B., Tom and all the boys knew that Ralph smoked, since he was continually smoking them on the ball-field.)

"Now it is my duty as President of this Society to warn its members of any danger to which they are exposing themselves. Do you not know that by smoking so early in life you are running the risk of greatly injuring your health? Am I correctly informed that you are a smoker?"

"Yes," said Ralph, "I acknowledge I smoke. I would like very much to stop. I have tried to stop several times, but I have found it almost impossible to do so."

"Do you know," said Tom, "that you are not only filling your system with poisonous substances from the tobacco and the paper of the cigarettes, thus greatly injuring your health, but that you are slowly burning up?"

"I am not sure of the burning up part," said Ralph doubtfully.

"Will you let me prove it to you, brother?" asked Tom.

"Yes," said Ralph.

"Shall I do this, brothers?" Tom asked in a serious tone of the members of the Society.

"Yes," was the reply, in chorus, "prove it to him."

"Then let the Honorable Chemist of the Society make the test with the magic goblet."

At this request, Rick brought an apparently empty goblet, and an apparently clean plate of glass. He placed several of the fingers of Ralph's right hand against the middle of the glass plate and brought the glass plate so as to cover the top of the goblet. To Ralph's great surprise, a copious stream of white smoke instantly began to pour apparently from his fingers, and passing through the glass plate into the goblet, soon filled it with dense smoke.

"See, brother," said Tom, "how the smoke pours out of your fingers. Observe how you are being slowly burned up by the poison your system has absorbed from the cigarettes."

"Yes, see him slowly burning up," said the members in a solemn chorus.

Ralph was, indeed, a greatly surprised boy. It certainly did seem as if the white smoke was actually pouring out of his fingers, and passing through the glass plate into the goblet. He could hardly believe his eyes, but there, sure enough, as it seemed to him, was the smoke, so that there must be something burning up, he thought.

"I didn't think it was as bad as that," said Ralph. "What strange fellows you are in the Society of the Jolly Philosophers. Of course, I don't really believe that the smoke comes from my fingers. Please explain this to me."

"Shall I permit the mystery of the magic glass to be explained to the new member?" asked Tom.

"Yes," shouted the boys in chorus. "Let the mystery be explained."

"The Honorable Chemist will explain the trick to the new member," said Tom.

Rick then showed Ralph, that the apparently empty goblet contained a small quantity of aqua ammonia, and that a drop of hydrochloric acid had been placed on the lower side of the glass plate immediately below the point which was touched by Ralph's fingers. As is well known to chemists, when these two substances are brought together they form a white, smoke-like material. The ammonia vapor, rising from the liquid, filled the goblet, and as soon as it comes in contact with the drop of acid on the plate, formed white, smoke-like fumes of a substance known to chemists as sal ammoniac, or ammonium chloride. Being heavier than air these fumes poured down into the tumbler giving the appearance of pouring out of Ralph's fingers.

As soon as Ralph understood this he said in a manly, good-natured tone:

"I know, boys, this is only a trick, but it is a capital trick. I also know that I am hurting myself by too much smoking. I am going to try to stop smoking from this time, and I ask you to help me. Whenever you see me smoking again please remind me of the promise I have made."

As soon as Ralph stopped speaking, Tom said:

"As members of the Jolly Philosophers, we are all supposed to be brothers. Will you all promise to help Ralph in conquering this bad habit?"

"We will," said the boys earnestly. "We will do all we can to help you, Ralph."

It may be mentioned here that Ralph, who had long been a slave to the habit of cigarette smoking, and had found that its shackles were bound fast to him, as, indeed, they may be to many a boy who reads this book, after a long and manly fight, eventually succeeded in freeing himself. On several occasions, while on the athletic field, he yielded to the temptation when he saw other boys smoking, but whenever one of the Society boys would come up to him and say:

"Ralph, remember your promise before the Society of the Jolly Philosophers," he would promptly throw his cigarette away, and remark:

"Thank you for reminding me."

After several such victories, the desire to smoke grew smaller and smaller, until at last he reached the happy condition of being able to see his companions smoking without having any desire to imitate them. Nor was Ralph the only one who won a victory in this fight. None of the boys, who were themselves smokers, could give good advice to Ralph, without practicing as they preached. The result, therefore, of the trick Rick played on Ralph on the night of his admission to the Society of the Jolly Philosophers, was that several boys besides Ralph stopped smoking.

X.

A. PHINEAS SKINNER ATTEMPTS VENGEANCE ON TOM

A. Phineas Skinner left Tom's laboratory on the afternoon he met the Membership Committee of the Secret Society of the Jolly Philosophers, raging inwardly. As is common in such cases, he never for a moment reflected, as a sensible boy would have done, that he richly deserved the punishment he had received, for he had not only broken his promise not to open the book, but had afterwards lied about it.

"I'll teach him," he muttered to himself, as he left the laboratory, "to treat me in such a shabby manner. Why, he couldn't have treated me worse if I had been a common boy," and he shook himself in anger, or, metaphorically, ruffled his feathers as an angry turkey gobbler would have done.

So A. Phineas Skinner determined to punish Tom for setting a trap for him, and all the more so, because he had been caught in that trap. But just how he could safely punish him was an entirely different matter. There was no reasonable doubt in Skinner's mind but that Tom could easily thrash him in a fair stand-up fight, so he promptly ruled out any plan that would bring about a fair fight, and endeavored to contrive some other way by which he could safely wreak vengeance on his enemy. After having formed several plans, which were on reflection set aside as being too dangerous, he finally hit on one that was satisfactory. This plan required several to help him. But we will not discuss it until he tried it on Tom.

The Saturday following Skinner's discomfiture was rainy, so that baseball, and much less a walk in the Park, were out of the question. Tom and Rick therefore spent the day together in the laboratory, reading Benjamin Franklin's Autobiography. The book described a number of experiments with Leyden jars. One of these especially attracted Tom's attention as offering great possibilities. In this experiment the two metallic coatings of a form of Leyden-jar battery were concealed in the frame of a picture. The outer coating of the battery was so connected with the frame that it would be difficult for one to take the frame in his hand without touching it. A conspicuous portion of the picture, to which especial attention was purposely directed, was connected with the inner coating. Tom's idea was to employ for this picture a photograph of their baseball team in which the colors of their team, which were made removable, were connected with the inner coating. He planned to show this picture to the members of any rival baseball team and dare them to try to remove the colors. Of course, as soon as one would attempt to do this, he would receive the discharge of the battery through his body and thus be properly punished for his audacity. If, as might often be the case, the boy should be suspicious and think that Tom was trying to play him a trick, which Tom's reputation made very probable, Tom would take the photograph in his hand, and holding the frame so that his hand would not touch the outer coating, would remove the colors without receiving the discharge. Tom afterwards found that this plan would always work; for, when the victim saw that Tom was able to remove the colors without anything occurring, he was always ready, on Tom's replacing them, to make the trial himself, thus falling into the trap.

When Tom explained this experiment to Rick, and said he intended at some early day to prepare the apparatus, the latter said:

"That is a capital joke, Tom. Let's get up something like it."

"All right, Rick," said Tom. "I have thought of something that will permit us to play a trick on any objectionable person who may come in this morning."

"All right," laughed Rick, in anticipation of the joke that he knew Tom could get up. "Tell me all about it."

"We will connect several concealed Leyden-jar batteries together, so that they will act as a single large battery. We will then connect its outer coating with a metallic plate, and its inner coating with some metallic conducting article, that we will place on the bench. This should be something that will so attract the attention of an inquisitive person that he will attempt to pick it up or touch it. Now, if we place the metallic plate and the decoy articles so that the person shall touch both of them at the same time with different parts of his body, say the metallic plate with one hand or foot, and the decoy articles with the other hand, he will discharge the battery through his body. I have not yet, however, been able to arrange things so that both of these contacts will be assured."

"Oh, there's no trouble about that," said Rick, who was a clever boy. "Connect the decoy articles with the inner coating and place them on the carpenter's bench close to the wall. Put a flat metallic sheet around the decoy articles, big enough to reach to the front of the carpenter's bench, but electrically separated from the articles. Any one attempting to touch the articles will have to lean over the bench, and the chances are that he will steady himself with one hand which will thus be brought into contact with the outer coating. Then as soon as he attempts to pick up the articles, he will be greatly surprised."

"Splendid, Rick," said Tom admiringly, "you're all right. Let's try it. We will divide all the Leyden-jar batteries into two large separate batteries. We will then connect the outer coating of one of them with the sheet of metal and the inner coating with the decoy articles."

"What will we use for the decoy articles?" enquired Rick.

"I will leave my gold watch," said Tom, "on the table. It is real gold," said Tom, smiling, "and was left me by my father. We will also put up what cash we have, so as to make an attractive looking pile."

"All right," said Rick laughing. "I'll put up my watch and all my spare cash."

So both boys began to go through their pockets and collect the money that was in them. In this way they were able to get together enough to make the combined pile reach the sum of sixty-two cents. This pile consisted of twelve pennies, three nickels, one quarter, and a ten-cent piece.

"It's a bigger pile than I thought we had," said Tom, chuckling. "We are far from being broke, yet, Rick, and can try some splendid experiments in electricity and chemistry with such a lot of tin."

"I guess," said Rick, laughing, "we have so much left because there have been so many rainy days that we have had fewer chances of investing our cash in candy."

"You're right, Rick," said Tom laughing, "I never thought of that."

The boys now put a large charge in one of the combined batteries and made the necessary connections with the inner and outer coatings. In order to prevent leakage across the top of the table, between the two coatings, the gold watches and the pile of money, were carefully placed on the middle of a sheet of hard rubber.

"Now, Tom, what shall we do with the second battery?"

"I have been thinking," said Tom, "of a plan by which it would be impossible for a person to approach me while sitting at this desk without receiving a severe shock from a battery."

"That's a good one, Tom," said Rick. "How will you do it?"

"We'll place a long sheet of zinc in front of the table," said Tom, getting out a sheet and placing it on the floor on the side of the table nearest the door; "so that it will be impossible for one coming into the room to get near the table without standing on the zinc plate. I will then cover the top of the table with another plate and connect it with the inner coating of the battery, which we will place where it cannot readily be seen. In order to prevent leakage between the table and the floor, I will rest the legs of the table on pieces of vulcanite or hard rubber. Any one coming in the room and attempting to get nearer to the one sitting at the table would step on the zinc plate on the floor. If then he should rest his hand on the plate on the table, he would thus touch both coatings and thus discharge the battery through his body."

These arrangements were made to the satisfaction of both boys, when Rick said:

"Now let's leave these traps, and get to something else."

"All right," said Tom, laughing, "but we must be careful not to fool ourselves, for these traps would catch us as well as they would some other person coming into the laboratory."

At this moment, Rick, placing his hand in his pocket, drew it out quickly and exclaimed:

"There, see what a chump I am!"

"What's the matter?" asked Tom, laughing at him.

"Why, look at this," said Rick, pulling an unopened letter from his pocket. "The postman gave it to me this morning as I was leaving the house to do an errand for mother. As I was only going around the corner I put the letter in my pocket, intending to give it to her on my return, but I entirely forgot it, and here I have had the letter for several hours. Wait for me, Tom; I will run around to the house and give it to her and will be back in a few minutes."

As Rick left the room, Tom went back to the table, and, carefully avoiding touching either the floor or the top of the table, commenced reading a part of Franklin's autobiography concerning experiments with Leyden jars. He became so interested that he entirely failed to hear the stealthy footsteps ascending the outside stair-case. Had he listened he would have heard the steps of more than one person stealing quietly up the stairs. He did not even hear the door open, until, feeling a draft of air on his face, he looked up and saw three boys sneaking into the laboratory. He recognized one of them as A. Phineas Skinner, who approached part of the way to the table and stood for a moment quietly in the middle of the room.

The other boys, who were strangers to Tom, were vicious looking rowdies, Skinner had persuaded to come along with him to see him, as he told them, "lick a fellow who had insulted him." The idea of seeing a scrap was so agreeable to the rowdies that Skinner had no difficulty in persuading them to accompany him.

When Skinner came into the room he looked carefully around to see if anyone was with Tom, but finding him alone, he approached the table and said in a threatening tone:

"Tom Bronson, I am going to give you a thrashing for the shameful way you treated me in this room last Thursday. So get ready to take your medicine."

"You mean," said Tom, in a quiet tone, "if you are able to give it to me."

"I am able all right," replied Skinner, "and these gents are ready to help me."

"What do you mean?" asked Tom contemptuously. "I don't see any gentlemen here; for, neither you nor the fellows who accompany you can call yourselves gentlemen after stealing into my room in this manner."

Tom was justified in speaking as he did; for, as soon as they got in the room, one of the rowdies shut the door, bolted it, and stood with his back against it, in order to prevent Tom from escaping, should he attempt to run away. The other had coolly commenced to walk around the room as if seeing what he could appropriate.

"So you don't think we are gentlemen?" remarked Skinner, wishing to get his rowdy friends angered with Tom. "Is that what you mean?"

"Yes, neither you nor your companions have any right to the name of gentlemen," replied Tom.

"We will see about that," said Skinner in an angry tone. He expected Tom to beg his pardon, and was enraged when he found that he and his companions were treated so contemptuously. He then drew a rawhide whip from his pocket, and approached Tom saying:

"I am going to give you the worst thrashing you ever had in your life. I will show you that you cannot play tricks on a boy like me without having to pay for it."

Tom sat quietly at the table and said:

"A. Phineas Skinner, since you insist on calling yourself in that ridiculous way, I warn you to beware. As a student of electricity, I am fully able to take care of myself. If you dare to approach me any nearer, I will blast you with a lightning flash. Now you have been warned, come on if you dare."

Skinner, remembering the severe shock he had received in this room on the day the Membership Committee of the Jolly Philosophers had left him in it alone, hesitated for a few moments. Seeing this, the rowdy, who was standing with his back against the door, called out to Skinner assuringly:

"Sail in, pard, he is only giving you hot air. Give him a good licking. We'll stand at your back."

At this moment, Tom saw that the other rowdy had approached the carpenter's bench and had rested one hand against the metal plate and was about to lean over the table to appropriate the watch and the pile of money.

"Look out there," said Tom, "don't touch the watch or the money. In the first place, they don't belong to you, and if you take them you will be a thief. In the second place, they are under the protection of Jupiter Tonans, or the Thundering Jupiter. Attempt to touch them and you will instantly be struck senseless by a lightning flash."

"Oh, get out," said the rowdy, "you can't queer me. I ain't afraid of none of your lightning flashes, or of the Jew, Peter Toenails," rather proud to think that he had so well remembered the odd name. "I am going to swipe the watches and the pile of coin, and don't you forget it." With that he reached over and approached his hand to the watch and money.

Skinner, seeing that the lad was about to commit a theft, cried out:

"Don't touch that money, Jerry; leave it alone. I didn't bring you here to steal, but to help me get square with that fellow sitting at the table. You stand there and wait a moment until I give him a thrashing."

His companion paid no attention to what Skinner said, but reaching over the table, he brought his right hand towards the coveted articles while his left hand was in firm contact with the metallic plate that rested on the surface of the bench. No sooner had his hand came in contact with the articles than a loud report was heard, and the fellow knocked senseless to the floor, on which he lay as if dead. In the meantime, Skinner, blinded by anger, and failing to notice what had occurred, rushed at Tom with the upraised rawhide in his hand. Pausing a moment, as he reached the table with both feet in good contact with the metallic plate in front of it, he said:

"Tom Bronson, get on your knees and beg my pardon," and with that he brought his hand in contact with the table. There was instantly a second report and Skinner also dropped senseless in front of the table.

The rowdy who was guarding the door, astonished at the fate of his companions, exclaimed in a horrified tone:

"Great Scott, what kind of a place have I struck? The outside for me!"

And unbolting and opening the door he rushed rapidly down the stair-case, and away from the building, for Tom could hear his feet pattering down the back street.

As soon as Tom saw that the boy at the door had gone, he ran up to Skinner and securely bound him by tying his hands with a piece of sash cord. He then did the same with the other boy. He had just completed this work when he heard steps on the stair-case. In a few minutes, Rick came running into the room, having returned from his home, where he had given his mother the letter. When he saw the boys bound with the sash cords lying on the floor insensible, he cried out:

"What is the matter, Tom? What have you been doing to these fellows?" And then going nearer to the boy lying near the table he cried:

"Why, it is Skinner. What has happened?"

"While you were away, Skinner stole into the room together with two rowdies, one of whom has run away. Skinner attempted to beat me with a rawhide horsewhip, but approaching the table he trod on the metal sheet connected with one of the coatings of the battery and then touched the piece of metal connected with the other coating. The discharge passed through him and knocked him senseless as you can see. Immediately before this, the other fellow attempted to steal the watch and money, and was also knocked senseless by the discharge of the Leyden jar through his body."

"Do you think they are seriously hurt, Tom?" asked Rick anxiously, for they were both still unconscious.

"Oh, no," replied Tom, "they are not seriously hurt. They got a strong shock, somewhat stronger than I had expected, but not strong enough to injure them. They will come to their senses in a few minutes."

In a few minutes, Skinner opened his eyes and said:

"Tom, you've served me right. It was a cowardly thing for me to steal into your laboratory with the two boys to try to whip you. But what has happened to the other fellow?" he asked, who was still unconscious.

"He brought punishment on himself by trying to steal that watch and pile of money over there on the table."

"Tom," said Skinner, earnestly, "I've been acting in a very outrageous manner, but I hope you will believe that I never for a moment thought that the fellows I brought with me would try to steal anything in your laboratory. I met them on the athletic field in the Park while playing ball, and asked them to come with me."

"Well, Skinner," said Tom, "you certainly ought to be ashamed of yourself."

"I am," said Skinner.

"Then," said Tom, "as you were once on our baseball team, I will let you go. Of course, after what has happened, you understand that you can no longer remain on the team. I am sure the other fellows will agree with me when I tell them what has happened. Now you can leave the room."

"I can't blame you, Tom, for feeling as you do," said Skinner, "or for putting me off the team. I hope you will forgive me, and not say anything about this disgraceful thing to the rest of the boys."

About this time, the other boy regained his consciousness.

"What is your name?" asked Tom, going up to him.

"Jerry Jones," was the reply.

"Do you go to school?" asked Tom.

"No, I am in the employ of the American District Telegraph Company, but cut work to-day and was playing ball in the Park, in the rain, when that fellow," pointing to Skinner, "asked me to come here."

"Do you know," said Tom to the boy, "I am going to call a policeman, and ask him to take you before a magistrate for breaking into my work-shop and attempting to steal. I suppose you know what the magistrate will do to you?"

"Yes," replied the boy, now thoroughly frightened. "I am sure that he will send me to the House of Refuge, at Glenn Mills. The last time I was before him, he said that if I was brought before him again he would send me there."

"Well," said Tom, "if that's the kind of a boy you are, and this is not your first offense, I guess you had better go to the Refuge."

"Please, mister," said the boy, beginning to cry, "don't do it. Give me a chance, and I will try to be a decent boy. I was going to steal, that's a fact. When I saw that watch and pile of money on the table, I made up my mind to swipe them, and now I am sorry."

"What do you say, Rick?" enquired Tom. "Shall I let him go?"

"Yes," replied Rick, who was a good-natured fellow, "give the boy a chance, but let him understand that you are in earnest and that if he gets into trouble again we will both appear against him for breaking in and attempting to steal. Here, I'll arrange it," and taking a note book from his pocket, Rick wrote something in it, and then read it to the boy. It was as follows:

"I, Jerry Jones, acknowledge breaking into the workshop of Thomas Bronson, and while there attempted to steal some money and a gold watch."

"Now," said Rick, "if you are willing to sign this, we will let you go."

"I'll be glad to sign it," said Jones.

"All right," said Rick, "but wait a moment," and writing something additional on the paper, he read to the lad as follows:

"I sign this paper of my own free will, and agree, should I again get into trouble during the next two or three months, that these boys may bring me before a magistrate for this offense."

After signing the paper, both boys left the room. Rick then said to Tom:

"Our Leyden-jar thief and blackguard detector has worked all right, Tom, hasn't it?"

XI.

SOME ELECTRICAL EXPERIMENTS IN TOM'S LABORATORY

Tom and Rick agreed to say nothing to the boys about Skinner's dishonorable attempt at vengeance. At first Rick wanted at least to tell the members of the Society, but Tom said:

"Let's give the fellow a chance to do better, Rick. I am sure he is truly ashamed of himself and will never do such a thing again. Besides, we must not forget that he labors under the disadvantage of having a rich father."

Rick smiled when he heard what Tom said. It was hard for him to understand how anyone could regard it as being unfortunate for a boy to have a rich father, so he said:

"Do you call having a rich father, a disadvantage to a boy, Tom?"

"Not always," replied Tom, remembering that Rick's father was rich; indeed, much richer than Skinner's father. "It certainly hasn't hurt you any, Rick. But it has Skinner, since, as you see, it has made him so stuck on himself, that he believes he is much better than any one else."

"I guess you are right," said Rick, after thinking for a few moments, and then added: "Well, you are the one most interested in this thing. If you wish, I'll agree to say nothing about it to anybody."

The fact that the lesson on the Leyden jar had been recited, by no means decreased the interest Tom and

Rick had in this electrical device; or, indeed, in the general subject of electricity. On the contrary, they spent much of their time in reading electrical books, in talking about what they had read, or in trying electrical experiments in Tom's laboratory. They did not, however, fail every now and then to visit the athletic field in the Park to play practice or match games of baseball. But it was the season of the year when thunder storms are common, so that they were obliged to spend many afternoons indoors, either in the public library or in Tom's laboratory.

Tom and Rick had been so much together during the past three or four weeks, that Rick was beginning to take a much greater interest in electricity than he had formerly done. Since Tom was far ahead of him in this subject, and was able to explain things clearly in electricity, Rick frequently came to him for help.

The Saturday following Skinner's discomfiture, like the preceding Saturday, was very rainy. Playing ball in the Park was unsatisfactory, so they spent the day in the laboratory.

Rick had been asking explanations from Tom about electroscopes, the name given to apparatus employed for testing the presence of electrical charges.

There was a point that Rick had been unable to understand. Tom therefore placed his electrical machine on the carpenter's bench and brought out an insulating stool; *i.e.,* a wooden stool, the legs of which are made of vulcanite, or hard rubber, an excellent non-conductor of electricity, and placing it on the floor, said:

"Stand on the stool, Rick, and I will show you how easily an electric charge in your body can be detected."

Rick got on the stool, and at Tom's request placed his hand on the electrical machine in such a manner as to permit the electricity to flow into his body when the handle was turned. When it had accumulated in Rick's body to a certain extent, Tom told him to take his hand off the machine. Now, since Rick was standing on the insulating stool, it was impossible for the electricity to escape from his body; for, it could not run off through the non-conducting air that surrounded him, nor could it pass through the legs of the stool to the floor, so it remained in his body. Tom now came near to Rick, without, however, touching him and began drawing one of his hands through the air near one of Rick's cheeks. Rick instantly felt a creeping sensation as if cobwebs or fine hairs were being drawn over his face. This made him laugh and say to Tom:

"Tom, I feel just as if you were drawing cobwebs over my face, or as if my whiskers were beginning to grow and you were tickling my face with them."

"I say, Rick," said Tom, "I believe the electrical treatment I have been giving you is sometimes used for making hair grow on bald heads. Wouldn't it be funny if I was able to raise a moustache or whiskers on your face. Think how jealous the boys would be if you came into the schoolroom with them."

"Thanks, Tom," replied Rick, laughing, "but I don't care to have any such things break out on my face for many years to come."

"Now, Rick," replied Tom, "place your hand again on the machine and I'll give you a stronger charge of electricity." As Rick did this, Tom continued turning the handle of the machine much longer than before. As more and more electricity flowed from the machine into Rick's body the hairs on his head began to stand straight up in the air, each individual hair acting as though it wanted to get as far as possible from the neighboring hairs. Rick's head began to look so funny that Tom grinned as he looked at it. There was a small looking-glass hanging up on the wall immediately in front of where Rick was standing.

"Look at yourself in the glass, Rick," cried Tom.

When Rick saw himself in the glass he began laughing, and said:

"It looks as though I was scared, don't it, Tom?"

"It does," replied Tom. "There is another way of telling whether you are electrified or not. Let me show you a method that is often employed for detecting feeble charges. Step on the floor for a moment in order to get rid of any electricity in your body."

Rick did this and evidently intended to stand some little while on the floor in order that no electricity should remain in his body.

"You can get on again at once, Rick," remarked Tom, laughing. "Your body was completely discharged almost the moment you touched the floor."

When Rick again got on the stool, Tom brought out a small but wide-mouthed bottle, in which he had hung two small strips of gold-leaf, to a narrow wire that passed through a cork inserted in the mouth of the jar. The part of the wire which projected above the top of the cork had soldered to it a small ball of polished brass.

"Is that an electroscope, Tom?" enquired Rick, carefully examining the instrument.

"Yes; it is called a gold-leaf electroscope from its two gold-leaves," he said, pointing to them.

"How do you use it to test whether a body is electrified or not?" Rick enquired.

"Touch one of your fingers to the brass ball," Tom replied, pointing to the brass ball on the top of the instrument. "If your body contains even a small trace of electricity the gold leaves will immediately fly apart."

Rick placed his hand as requested, but since his body had been completely discharged when he stepped on the floor, no motion of the gold-leaves could be seen.

"Now," said Tom, "see how easy it is to electrify you." With that he gently rubbed him on the back with a piece of cat's fur. At the first stroke the gold-leaves immediately moved away from each other. Rick, who was greatly interested, exclaimed:

"Tom, the gold-leaves are acting just as the hairs on my head did."

"Yes," replied Tom, "you could be used for an electroscope, but this instrument is much more sensitive."

Although Tom had ceased rubbing Rick with the cat's fur, yet the leaves still stood apart from each other.

"Tom," enquired Rick, "how long will the leaves be kept apart?"

"When the air inside the jar is perfectly dry they will remain apart for two or three hours or even longer," replied Tom.

"Then," said Rick, who had been thinking, "why wouldn't it be a good idea to place a small quantity of calcium chloride in a small open mouth bottle inside the electroscope. This chemical, as you know, will draw the moisture out of the air, and thus keep it dry, so that the gold leaves would remain apart for a longer time."

"Rick," said Tom in his admiring tone, "that's a capital idea. Let's make two gold-leaf electroscopes, one for you, and one for me, and place calcium chloride in them. Then, in order to still farther prevent the leaves from losing their charge, instead of an ordinary cork, we will use a stopper made of vulcanite, which is a very good insulator."

"Very well, Tom," replied Rick. "I'll run around to the house and get some calcium chloride. I'll be back inside of ten minutes."

When Rick returned they began the construction of the electroscopes. After working hard for several hours, the two instruments were completed, and proved not only to be very sensitive to small electric charges, but, when charged, the leaves continued apart for several hours.

This work being done, Tom now showed Rick an experiment that greatly interested him. Filling a large jar with dense smoke, he stuck one end of a piece of wire in the top of the jar, and connected the other end to the electrical machine in such a manner that when he turned the handle, the electricity passed from the machine into the jar, when, almost instantly, the smoke cleared away, so that in a few seconds the air was quite free from smoke.

"How curious," said Rick, as he watched the smoke rapidly disappear. And then thinking a moment, he said:

"I understand how it works. It is like the experiment with the hairs of my hand, or with the gold leaves in our electroscopes. As soon as the particles of smoke are electrified they try to get as far apart from each other as they can and are thus thrown against the sides and bottom of the jar, thus clearing the air."

"Capital, Rick," said Tom, admiringly. "You'll make a great scientific man. You observe things so well and reason about them so clearly."

XII.

THE THUNDER STORM

After lunch the boys again went to the laboratory. By this time the rain had stopped falling, the sun was commencing to break through the clouds, but the air was very sultry. Indeed, it became so close in the laboratory that the boys concluded to make no further experiments but to take a walk in the Park.

"The ground will be too wet to play ball," said Tom, as if apologizing for suggesting a walk instead of a game.

They entered the Park at the Ridge Avenue entrance, immediately north of the Park trolley road, and were soon crossing the handsome bridge that spans the Schuylkill River at this point. This bridge is provided on one side with tracks for the trolley cars, and on the other side with a roadway for vehicles and foot passengers.

"Let's cross over towards the Speedway," said Tom, when they reached the west bank of the river.

The boys took a pleasant walk through the Park, along the Speedway, and on the western banks of the Schuylkill. During their walk they talked about different things that interest boys.

After awhile the subject turned to the lightning flashes, for there had been heavy thunder storms almost every evening that week. After nearly an hour's walk they reached the top of a high hill overlooking the Schuylkill River, when they sat down on a bench under a tree to rest. Here a beautiful view could be had both up and down the river, as well as the eastern bank. On the river itself, could be seen many shells or barges in which the different boat clubs of the Schuylkill Navy were practicing for the races that were to take pace during the regatta on the approaching 4th of July. From where they were sitting they could distinctly hear the gasoline motor boats on the river, or the similar but louder sounds of the nearer motor cycles on a driveway close by. A long string of horses and carriages, automobiles, and bicycles could be seen passing up and down the drive.

The sky was clear in the east, but towards the western horizon, a bank of dark-colored clouds was beginning to form. The air had grown oppressively hot, so that the shade of the tree under which their bench was placed, was very grateful.

As they sat watching the bank of clouds in the west, they could distinctly see dark-colored clouds known as thunder-heads, slowly rising from the mass.

"I think we are going to have a thunder storm," said Tom.

"It looks like it," replied Rick. "I say, Tom," he said, continuing, "do you know why those dark-colored clouds are called thunder-heads? Do you suppose that they contain any more free electricity than ordinary clouds?"

"I am not certain," replied Tom, "but it is popularly believed that they do, and I understand scientific men are now inclined to think that this belief is correct, for a cloud of steam at once becomes much darker in appearance when an electric charge is permitted to enter its mass."

"What's the reason for that, Tom?" enquired Rick.

"I don't know, Rick," was the reply. "Generally the passage of an electric charge through a mass of small particles of smoke or vapor results in its rapid settling as we saw this morning in the laboratory. Probably because the particles of vapor, when they strike against one another, instead of flying apart, cling together."

As they sat watching the clouds in the west, it became more and more evident that a thunder storm was approaching. The thunder-heads rose higher in the air, and occasionally the rumble of distant thunder could be heard, as flashes of lightning momentarily lighted up the western sky.

"The storm in coming all right," said Rick. "What a splendid place we are in to observe it, Tom. Let us stay here awhile and learn what we can about thunder and lightning. I know you don't mind getting a little wet. When it begins to rain hard we can take shelter under this tree."

"All right," said Tom, "I should like to watch the coming storm."

So they sat watching the brewing of what promised to be a great storm. Seething masses of dark clouds made the air look as if it was being fiercely boiled in one of Nature's huge caldrons. Feathery, fleecy clouds began to form in layers in the higher parts of the atmosphere near the bank of clouds in the west. The dark cloud advanced rapidly towards the east, thus heralding the coming storm.

The air suddenly grew colder, as the rapidly forming eastward moving clouds cut off the light and heat of the sun. As the black cloud mass moved towards the east with a velocity of, perhaps, thirty or forty miles an hour, a light, grayish, ragged squall cloud was thrown out from beneath the dark mass.

As the squall cloud moved rapidly towards where the boys were sitting, clouds of dust reached them. Large drops of rain began to fall. They were so interested in watching the storm that they forgot to get under the tree for shelter, and were soon drenched to the skin. Tom, therefore, said:

"It doesn't make any difference now, Rick. We are as wet as we can be; let's stay here and watch the storm."

"That's right, Tom," was the reply.

On several occasions, they noticed that after an especially heavy clap of thunder, the falling raindrops increased markedly in size.

"Tom," enquired Rick, "do you believe that the large raindrops are caused by the thunder shaking the air, thus bringing many very small drops together? I have often heard people say that this is the reason."

"I think that is no longer believed, Rick," said Tom. "Don't you remember the experiment we tried in the laboratory when we rapidly cleared the air in the large jar filled with smoke by passing an electric charge from the electric machine through its air? You remember, too, we were talking a few moments ago about the dark lurid appearance of thunder-heads, possibly being due to the particles of the cloud when electrified clinging together as they strike one another, and thus increasing in size. That is, probably, also the explanation of the larger raindrops that follow heavy peals of thunder. The lightning flashes electrify the drops of rain, and cause them to strike one another and thus increase in size. It is not the shaking of the air produced by the thunder but the movements of the smaller raindrops under the influence of their electric charges."

As the storm drew nearer, the lightning flashes became more and more frequent. Tom called Rick's attention to the fact that the time between the lightning flashes and the accompanying thunder also grew shorter and shorter, thus showing that the flashes were getting more nearly overhead.

The lightning flashes now followed one another with great rapidity. They were standing under a burr oak tree near one of its outer edges, when suddenly, Rick caught Tom by the arm, pulling him along with him as he ran rapidly away from the tree.

"What's up, Rick?" asked Tom.

"I feel cobwebs being drawn over my face," replied Rick. "There must be much electricity in the tree. We are in danger of being struck," he said, as he still kept pulling Tom along with him as he ran rapidly away from the tree.

Tom, who now saw the great danger to which they were both exposed, ran rapidly with Rick from the tree. Before they had run more than three hundred feet, there was a blinding flash followed almost immediately by a deafening peal of thunder. Looking back, towards the tree under which they had been standing, they saw that it had been struck and splintered into a great number of small pieces. If they had remained under it they would have been instantly killed.

"That was a close call, Rick," exclaimed Tom. "Your quickness in observing the cobweb feeling on your face has saved our lives."

The storm was now almost directly overhead. In a few moments there was a second flash that was again followed almost immediately by a peal of thunder.

"That struck very near where we are now," said Tom.

"Yes," replied Rick, "I think it struck the ground somewhere on our right."

THERE WAS A BLINDING FLASH, FOLLOWED ALMOST IMMEDIATELY BY A DEAFENING PEAL OF THUNDER

The lightning flashes now followed each other less and less rapidly, the rainfall grew less, and finally ceased altogether, the heavens began to clear; and soon a patch of blue sky appeared in the west, while the air grew cooler and cooler.

As soon as the storm was over, the boys went to examine the tree that had been struck by lightning. They found it broken into a great number of splinters, which hung like festoons on all sides, while the ground was strewn with smaller fragments that had been broken off. The fragments were hanging to the tree as if the tree had been blown into pieces by some force acting from within, rather than by being shattered by a stroke from without.

Rick, who had brought a small kodak camera with him, took two exposures of the tree, since he wished to get a good picture to show at the next meeting of the Jolly Philosophers.

"Let's try to find where the lightning bolt struck the ground," said Tom.

After a search of five or six minutes, they found a place where the ground had been torn up, and where the flash had evidently entered the ground, which consisted here of a sandy soil.

"Rick," said Tom, "when a very heavy bolt strikes a sandy ground it often fuses the sand and forms a kind of natural glass in the path taken by the discharge. This mass of glass generally takes the shape of a branching tube, and called a lightning tube or fulgurite. Let's see if we can find such a tube. It would be a splendid thing to exhibit before our society at its next regular meeting."

"If such a tube has been formed," said Rick, "won't it be too hot to handle?"

"I think not," said Tom. "There has been a heavy rain, and sandy soil is porous, so that if a tube has been formed, it will probably be cool by this time."

On examining the ground, to their great delight the boys found a well formed lightning tube formed by the melting of the sandy soil, as the discharge passed through it. As Tom predicted, it had been cooled by the rain so they were able to handle it. After considerable digging they succeeded in taking it out of the ground without breaking.

The boys were now thoroughly wet and, therefore, made no attempt to ride home, but walked at a rapid gait which prevented them from becoming chilled. On reaching home each took a bath, and put on dry clothes.

The first thing they did on meeting afterwards at the laboratory was to develop the pictures Rick had taken of the shattered tree. Tom had built a photographic dark room in one corner of the laboratory. It was provided with a water-tap, while a red glass in a light-tight door, provided light for developing and fixing. At night a lighted gas-jet, placed in front of the sheet of red glass furnished light in place of the sunlight in the room for developing; for, Tom, like Rick, was a good amateur photographer.

The boys found that both exposures had given excellent pictures of the shattered tree.

They then closely examined the lightning tube or fulgurite, and agreed to prepare a joint, scientific paper to be read at the next meeting of the Society. In this paper they determined to describe their experiences during the thunder storm, as well as to describe the formation of the fulgurite or lightning tube. They also intended to exhibit the photographs of the shattered tree.

As Rick was leaving the laboratory at supper time, Tom said to him:

"Rick, I would not be surprised if we had another thunder storm to-night. The air is again growing sultry, and another bank of clouds appears to be forming in the west. Come to the laboratory to-night after supper, and bring your camera with you, and we will try to get good photographs of lightning flashes should there be any."

"That's a capital idea, Tom," was the reply. "I'll be sure to come."

XIII.

TOM AND RICK TAKE PHOTOGRAPHS OF LIGHTNING FLASHES

The idea of photographing lightning flashes so excited Tom and Rick that they were at the laboratory not long after 6.30 P.M.

Both boys had cameras capable of taking fairly large plates, Tom's camera taking 4 x 5 plates, and Rick's 5 x 7 plates. The boys at once went into the dark-room in order to put plates in their plate-holders.

"What kind of plates did you bring Rick?" asked Tom.

"The fastest I have," replied Rick, "since the lightning flash continues but for a short time. What are your plates, Tom?"

"I am also using the fastest plates I have," was the reply.

When the plate-holders were loaded, they went into the laboratory, and raising the sash of the window facing the west, as high as it would go, they placed their cameras so as to point them towards the western horizon.

"We must focus," said Tom, "on some distant object, such as, a cloud, so that, should a lightning flash occur, its image will be sharply formed on the photographic plate. If a thunder storm comes we will expose the plate to the sky, and since the night will be dark, the plates will not be much affected until a lightning flash comes. As soon as this occurs we will close the plate-holder, expose a fresh plate, and so on until the storm is over, when we will develop our plates."

"I hope there will be a storm, Tom," said Rick.

"So do I," said Tom, and continuing, he remarked: "And now, there is nothing to do but to wait for the storm to come."

While waiting the boys began reading books they had taken out of the library with the idea of learning all they could about lightning flashes. As was usual, every now and then the reading was interrupted by conversation. Rick, who had been reading something about the common belief of a lightning flash as instantaneous, asked Tom whether he thought it was true.

"No," said Tom, "at one time the flash was believed to be instantaneous, but it is now certain that a definite time exists between the beginning and the end of the flash. Although this time is very short, yet it is far from being instantaneous, the flash continuing, for, perhaps, as long a time as 1–100,000 of a second. Indeed," he added, "a lightning flash cannot be instantaneous."

"How do you make that out?" enquired Rick.

"Because," replied Tom, "a lightning flash, like the discharges of a Leyden jar, does not consist of a single flash but of a great number of separate flashes following one another at exceedingly brief intervals and flowing alternately in opposite directions. Since the flash consists of a number of separate discharges, the entire discharge cannot possibly be instantaneous."

"Do you know any book that treats of the different kind of lightning flashes?" enquired Rick.

"Yes," replied Tom, "I have a three-volume book here that contains much information concerning lightning flashes."

"Then let us read it together while we are waiting," said Rick.

The boys turned to the book and began to read what it had to say about lightning flashes. They thus learned that lightning flashes occur in a number of different forms, one of the commonest of these forms is known as forked, or more popularly, zig-zag lightning. This latter name is misleading, since photographs of lightning flashes never show sharp angular bends, or zig-zag paths, but rounded bends not unlike the curves in the channel of a river in its lower course.

"If we get photographs of lightning flashes, we will examine them and see if this is true," said Rick.

Continuing to read, they found that there was another common form of lightning flash called sheet lightning, which consists of an expanded flash that lights up the edges of the clouds as well as parts of the surfaces of neighboring clouds. This kind of lightning is not accompanied by thunder, because the flash is too distant to permit the thunder to be heard.

A much rarer form is that known as globular lightning. Here the discharge takes the shape of a ball of fire that either remains at rest in the air, or moves slowly through it until it finally disappears. The book they were reading referred to a case where a large ball of fire descending the chimney of a small house and entering the kitchen, rolled slowly over the floor, until it reached a side of the room, where it quietly disappeared through a crack in the wall, without injuring any one.

Globular lightning, however, is not always harmless. The book mentioned a case in which a ball of fire struck the mainmast of a ship and tore a hole in the upper deck when it exploded, with bright sparks and a noise like a roll of musketry. Several large hoops surrounding the mast, were broken and scattered in all directions. A sailor, who was standing near the hole on the deck, was so severely burned by the flames that he died in great agony several days afterwards.

Still another form of lightning is called chain or bead lightning. Here the discharge has the appearance of a number of luminous beads strung together in the form of a chain.

Perhaps the rarest form of lightning consists of multiple or ribbon lightning. Here the discharge does not consist of a single flash, but of a number of separate flashes rapidly following one another in almost but not exactly the same air space. The peculiarities of this rare form cannot be detected except by means of photography.

"How odd, Tom," replied Rick. "I wonder what appearance this form of lightning would possess."

"There's a photograph of multiple or ribbon lightning in the book I am reading," said Tom, pointing to a photograph taken by Mr. John M. Justice, of Philadelphia. Is he any relation of yours, Rick?"

"I don't know," was the reply. "I hope so, as he must be a brainy man. He certainly understands photography," said Rick, closely examining the picture.

The photograph referred to showed a lightning flash consisting of fourteen separate and distinct flashes. It had the appearance of a banded ribbon.

"See, Tom," said Rick, "there are no zig-zags or sharp corners in these flashes. They are rounded like the bends of a slowly moving river, just as you read a few moments ago. Wouldn't it be splendid if we get a photograph of this kind of lightning?"

"It certainly would," replied Tom, "but our chances to do so are small, for I understand that this form of discharge is quite rare."

While carefully examining the photograph of the multiple lightning flash, the boys were silent for a few moments for they were both busily engaged in thinking. At last Rick said:

"Tom, I don't understand this at all."

"Well, my boy," said Tom, laughing. "I guess there are plenty of other people who don't understand it. But tell me what particularly troubles you about the multiple lightning flash."

"Why," answered Rick, "I have been wondering whether each of these parallel flashes consists of one of the many alternate discharges present in all lightning discharges, that have been retarded back of one another so as to pass through adjoining portions of the air that are near together, or whether each of these separate flashes are themselves like ordinary discharges, oscillatory."

"Phew," replied Tom, admiringly, "you're going very deep into the matter, Rick. Your questions are too much for me. Let us ask Mr. Askinson about it the next time we see him."

"Or Mr. Alexander," suggested Rick.

The boys kept on reading and talking together until eight o'clock, when the bank of dark clouds Tom had observed late in the afternoon in the western heavens, began rapidly to increase, thus indicating a coming storm. Shortly afterwards they heard footsteps ascending the outer staircase, and two of the boys, Ralph Coffin and Abe Levy, entered the room.

"Good evening, Tom," said Ralph. "Abe and I started out for a walk around the East Park Reservoir, but we concluded to turn back on account of the approaching storm. Seeing a light in your laboratory we came up.

It looks so snug and cozy here that unless you and Rick wish to be alone, I would like to stay."

Ralph was a very gentlemanly boy and made this remark fearing that they might be intruding.

"Stay by all means," said Tom. "Both Rick and I will be pleased to have you. Ain't that so, Rick?" he asked.

"Yes," replied Rick, "stay here; it will be all the jollier."

"Thank you," replied Ralph. "Then I'll stop. The room looks much more comfortable and pleasant than when I was here last. Where have you put the skull, crossbones, daggers, and other awful things?" he enquired.

The other boys laughed when Ralph thus referred to the horrible things he saw on the night of his initiation to the Society.

"Yes, the room looks more homelike," replied Rick. "I say, Ralph," continued Rick, "wasn't that a good initiation? Are you sure that you have entirely recovered from your fright?"

"Yes, Rick," replied Ralph good-naturedly, "I am all right now. Feel my pulse," he said, extending his wrist towards Rick, "you will find my heart beating no more rapidly than it should. But what were you doing when we came in?"

"We were waiting to take some photographs," said Rick.

"Photographs at night!" exclaimed Ralph in surprise. "Where is your light? Oh, I know," he replied, after thinking for a moment, "you are going to take pictures by a flash light."

"Yes," replied Tom laughing, "we hope to take some flash light pictures, but not the kind you are probably thinking of. If there are any lightning flashes during the coming storm, as we hope there will be, we intend trying to obtain some photographs of them."

"The storm is coming all right," said Ralph, "and as you have kindly invited us to remain, I will stay and see you do the trick. What jolly fellows you and Rick are for such things."

"Let be stay too, Tob," said Abe, "I wadt to see how it is dudd."

"All right," replied Tom, "we will be glad to have you stay, Abe."

As the boys sat down, Ralph said:

"Go on please with what you were doing when we came into the room, or we shall feel we are intruding."

"Rick and I were reading and talking about lightning," said Tom.

The boys sat down, and during the next half hour were busy reading and talking. Of course, the conversation soon got on the subject of photographing lightning flashes. Tom explained to them how he hoped to obtain photographs of any lightning flashes that might occur during the coming storm."

"Tob," said Abe, "I have heard it said whed a lightdidg stroke strikes a persod, who bay be dear a tree, that it bakes a picture of the tree on his skid. Have you ever heard of this, and do you believe it to be true?"

"Yes, Abe," replied Tom, "I have heard that story, and I understand that it was once commonly believed. But it is now generally, although not entirely, discredited. While tree-like markings are found on persons struck by lightning, yet they do not consist of photographs of trees, but are caused by the small blood-vessels near the surface of the skin becoming gorged with blood under the influence of the shock caused by the stroke."

"Tom," said Ralph, "if it is not too much bother, won't you explain to me something about the electricity of the atmosphere?"

"I am afraid, Ralph," answered Tom, "you think I know more of this subject than I really do. However, if you let me know just what you want explained, I shall be happy to tell you as much as I can."

"Well, then," replied Ralph, "to begin with, is it known just how the atmosphere gets its electricity? I am pretty sure it must have something to do with heat and moisture, since I know that it is generally in summer towards the close of a very hot day when there is much moisture in the air, that thunder storms most often occur."

"You're a good observer, Ralph," said Tom. "As far as I can understand from the books I have read, it is not exactly known just how the free electricity in the atmosphere is produced. It seems there is no single cause, but that a number of separate causes combine to produce it. Some believe that the principal cause is the rubbing of particles of dust against one another or against the surface of the earth. Others believe it is due to the friction of particles of water against the earth. Still others believe its principal cause is the evaporation of water from the ocean." Tom then explained at some length how these different causes were believed to act.

Ralph gave close attention to Tom's clear explanation of the probable cause of electricity. He was a bright fellow and readily understood all that Tom said.

"I am much obliged, Tom," he exclaimed, when Tom was through talking. "You are a capital teacher."

"Tom," said Rick, "let's show the boys the photographs we got this afternoon in the Park of the tree that was struck by a lightning flash, and the lightning tube, unless, of course," he added, seeing that Tom hesitated, "you prefer keeping them until the next meeting of the Jolly Philosophers."

"I have no objections, Rick," was the reply. "Suppose we show the photographs and keep the lightning tube until the meeting."

On Rick agreeing to this, they showed Ralph and Abe the photographs and gave them a full account of their experiences during the thunder storm. Their visitors were much interested and carefully examined the photographs.

"That must have been a very powerful stroke," said Ralph, looking at the way the tree had been splintered.

"It bust indeed have beed a strodg stroke," said Abe. "See how it has splidtered the wood. It looks bore as if the wood had bed blowd apart rather thad tord apart."

"What do you mean?" inquired Tom of Abe.

"I bead that it looks bore as if the tree had exploded add blowed out rather thad blowd dowd. As you cad see the broked parts dod't all lie od wud side of the tree."

"Capital, Abe," said Tom. "I agree with you in thinking that the tree looks as if it had been blown up rather than blown down. The power of a lightning stroke to break or tear solids like wood is due to gases or vapors being suddenly formed by the great heat of the discharge. When discharges from large Leyden jars are sent through such non-conducting substances, as sheets of wood, paper, glass, etc., the heat tears the substance apart largely by the explosive formation of masses of vapor within it. This occurs when a Leyden-jar battery is discharged through the leaves of a book. I can show you this experiment if you would like to see it."

"Show it to us, please, Tom," cried the three boys in chorus. "We would all like to see it."

At this request, Tom discharged one of his large Leyden-jar batteries in such a manner that the electricity passed from the front to the back of a paper book containing some 100 leaves. A loud report was heard as the discharge, passing through the book, pierced it.

"Now," said Tom, showing the book to the boys, "see how the separate leaves, especially those near the covers, not only show holes but that the edges of the holes have been burred or raised on both sides of the sheet."

"That's very beautiful, Tom," cried Ralph. "As the electricity passed through each sheet of paper it produced a vapor inside the leaf. This vapor exploding passed out at both sides and thus produced a raised edge or burr, on both sides."

The boys kept up this conversation for sometime afterwards, but at last a distant peal of thunder was heard.

"Hurrah!" cried Rick, "here comes a thunder storm."

"I hope so," said Tom, as he approached the window followed by the other boys.

On looking out of the window they saw that a storm was rapidly approaching from the west. At once turning down the gas lights in the room and uncovering their plates they anxiously awaited its coming. When the storm was nearly overhead they succeeded in obtaining exposures of a number of very powerful flashes, one of which was especially large.

As soon as the storm had passed over, and there were no further flashes, they brought their cameras inside the room and closed the window.

"Now," said Tom, "let's see if we have anything on the plates. I hope we shall get at least one good picture."

Then turning to Ralph and Abe, he said: "If you are willing to pack close together, I think we can all get in the dark-room while the plates are being developed."

It was tight packing, but as the boys were greatly excited over the possibility of having obtained a picture of a lightning flash, and were anxious to see the developing, they willingly packed close together and watched Tom as he prepared to develop the plates that Rick and he had exposed.

To their great disappointment, the first two plates contained nothing. At last one of the plates from Tom's camera and a plate in Rick's camera, that had been exposed to the same lightning flash, showed good pictures of an ordinary lightning flash. As soon as Tom had completed the development he placed it in the fixing bath of hypo. There was now a single set of plates remaining. These had been laid aside by Tom as being exposures to the particularly strong flash that had occurred when the storm was almost directly overhead.

"Now, Rick," said Tom, "these ought to be our best."

On developing the 5 x 7 plate, both Tom and Rick shouted with joy as they both recognized the picture of a multiple or ribbon flash, slowly but distinctly appearing on the plate.

"What a magnificent photograph," cried Tom. "See," he added, holding up the plate so that the light from the pane of red glass could shine through it, "there are a number of distinct and separate flashes."

"Yes," said Rick, "and see, Tom, the bends in the flashes are not zig-zags, but are rounded or curved.

The development of the 4 x 5 plate showed that they had obtained a similar excellent photograph of the multiple flash.

As soon as the pictures had been thoroughly fixed in the hypo bath, Tom replaced them in a bath through which a stream of water was kept slowly flowing.

"Why do you do that?" asked Ralph.

"To wash out all the hypo from the film. If permitted to remain, the hypo would spoil the negative, or the photographic image you see on the plate."

"This is all quite new to me, Tom," said Ralph. "Won't you tell me why that photograph is called a negative?"

Tom explained that the name negative was given to such a photograph because when the image formed by the camera lens was thrown on the plate, the light portions of the image made the parts of the sensitive surface on which they fell become dark-colored, or opaque to light, while the dark portions, or those on which little or no light fell, were left unchanged. That when the plate was placed in the hypo or fixing bath, the unchanged parts of the plate were dissolved or removed; thus leaving the glass plate clear, while the darkened parts remain darkened. Therefore, on its removal from the fixing bath, the picture is called a negative because it is a picture in which all the light portions of the object are represented as dark or shaded portions, while the dark or shaded portions are represented as light or transparent parts.

In order the better to illustrate what he had been saying, Tom took one of the plates from the washing bath and showed Ralph and Abe just why it was called a negative.

"Thank you, Tom," said Ralph, "I understand this very well now. When the negative is placed over the sheet of sensitive paper, the light passes through the clear part of the negative, turning those parts of the paper black, while being unable to pass through the dark parts, leaves the paper white, or in this way produces a positive or picture of an object with its lights and shades as in nature."

"That's a capital statement, Ralph," said Tom.

The boys continued talking for sometime afterwards when they all left the laboratory, but not, however, before Tom had asked them not to mention to the other members of the Society what they had seen.

XIV.

HOW FRANKLIN ROBBED JUPITER OF HIS THUNDER-BOLTS

During the early part of the next week, Tom and Rick spent most of their spare time in obtaining additional information on lightning. Immediately after school on Monday afternoon they took their cameras to the Park and obtained additional pictures of the tree as well as of the spot where they found the lightning tube.

There were great times at the regular meeting of the Jolly Philosophers on the Friday night following Ralph's initiation. The principal attractions were the papers read by Tom and Rick on lightning flashes.

Tom's paper referred principally to their study of lightning flashes based on the photographs obtained on the Saturday night in the laboratory, when they were visited by Ralph and Abe.

In his paper, Tom called attention to the fact that a charged cloud closely resembled a charged Leyden jar.

"A Leyden jar," he said, "consists of two metallic plates, placed on opposite sides of a glass jar. Now, a lightning stroke is like the discharge of a huge Leyden jar. The cloud forms one of the coatings or plates, and that part of the earth immediately under the cloud, the opposite coating. These coatings are separated from each other by the non-conducting air between them, just as the coatings of the jar are separated by the non-conducting glass. When a Leyden jar is discharged, there is not a single rush of electricity from one coating to the other, but the discharge flows first in one direction and then in the opposite direction, and this goes on for a number of times until the jar is completely discharged. So, too, when a cloud discharges, the electricity flows first in one direction, then momentarily stops and flows in the opposite direction, these oppositely directed discharges being repeated until the cloud is completely discharged. A charged Leyden jar resembles a bent spring; its discharge is like the releasing of the spring. When a bent spring is released it moves rapidly towards a straight or unbent position. But it does not stop when it reaches this position. It continues moving far beyond it, becoming bent in the opposite direction, and only resumes its original unbent position after a number of to-and-fro motions. A lightning flash, like the discharge of a Leyden jar, is also oscillatory, the discharge rapidly moving in opposite directions, until the opposite charges in the earth and the cloud completely neutralize each other."

Tom then called attention to the difficulty of observing peculiarities of lightning flashes on account of their short duration, so that if photographs of these flashes could be taken they could be studied much more conveniently.

"On Saturday afternoon," said Tom, "while walking through the Park with the distinguished chemist of our Society," pointing towards Rick, "we were fortunate in being able to study the severe storm of that afternoon. As some of its peculiarities will be given in a paper by our chemist," again pointing towards Rick, "I will only speak about some photographs we obtained at the laboratory during the storm Saturday night.

It was clear that neither Ralph nor Abe had said anything to the members of the Society as to what they had both heard and seen during their visit to the laboratory on Saturday night; for this statement caused no little stir among the members.

Tom now passed around a number of separate silver prints taken from the photographic negatives of the forked lightning flash obtained on Saturday night. He first called attention to the fact that the name, zig-zag lightning, commonly given to this form of lightning, is incorrect, the path of the lightning discharge not being abrupt or zig-zagged, but gradual, like the bends of a river in that portion of its basin near its mouth where it flows sluggishly.

"But," continued Tom, "we were also fortunate in getting a photograph of the exceedingly rare form of lightning that you can see on the prints I now show you. This is the form known as multiple or ribbon lightning. As an examination of these photographs shows, this was not a single discharge, but a number of separate discharges rapidly following one another in nearly the same place. Each discharge took a path parallel to the preceding discharge. No less than thirteen of these distinct and separate flashes can be counted in the photograph. The popular idea that lightning never strikes twice in the same place, therefore, must be modified, since here we have lightning striking thirteen times in nearly the same place."

Rick's paper was entitled, "Some Effects Produced by Lightning Flashes." He said in part:

"As long ago as the year 1752, Franklin proved that lightning flashes consist of electric discharges passing between a cloud and the earth, or between the two neighboring clouds. It is evident, therefore, that the effects produced by lightning flashes must be of the same general character as those produced by the discharges of powerful Leyden-jar batteries."

He then called attention briefly to the fact that electric discharges are capable of producing many different effects; such, for example, as mechanical effects, as in the rending, tearing and splitting of the non-conductors through which they pass; heating effects, as seen in the fusion or volatilization of metals; luminous effects, as in the almost blinding flash of the lightning discharge; chemical effects, as in the combination of the oxygen with the nitrogen of the air; magnetic effects, as in the reversing of the polarity of the mariner's compass; and, finally, physiological effects.

"Now," said Rick, "having mentioned the principal effects of lightning discharges, I wish to show you some of the mechanical, heating and chemical effects that were observed by our President and myself during the thunder storm in the Park last Saturday afternoon."

He then related, how, while they were standing under a tree in the Park, they experienced a peculiar feeling as if cobwebs were drawn over their faces; and how, after having hurriedly left the tree, it was almost immediately afterwards splintered by a nearly blinding flash that was almost instantly followed by a deafening peal of thunder. He then gave a short account of the second flash, and the formation of the fulgurite or lightning tube.

"We took several photographs of the shattered tree. As you can see from these prints," which he then passed around, "the lightning bolt possessed considerable power. Now we have here an example both of the mechanical power of the stroke and of its heating power, for the prints appear—seem to show that the breaking up of the tree was due rather to an explosion caused by the sudden formation of gases or vapors within the mass of the wood, than to a mere mechanical force or blow from the outside."

There was great surprise among the members when Rick called attention to the lightning tube, which he had previously placed on the top of the President's table, covered with a large handkerchief, which he removed when he began speaking about it, saying:

"A second very severe lightning flash that occurred shortly after the stroke which shattered the tree, entered the ground near us at a place where the soil was sandy. Here the heat produced by the discharge fused the soil and thus formed a natural glass. You can see that the glass has only been formed in the path of the discharge."

There was great applause from the members at the close of both Tom's and Rick's papers. They were all proud of what two of their fellow-members had done.

During the half hour or so at the close of the Society, the boys treated themselves to their usual jolly time. Tom had arranged to play a joke on some of the members of the Society by exhibiting the photograph of their baseball team, that he had shown to Rick, on which were placed the removable colors of their team. All the members, however, of the Society were either members of the team, or of the grammar school, whose colors were the same as those of the team, and, therefore, would not wish to remove their own colors. Tom had cleverly replaced the school colors by the colors of a rival team. In order to tempt one of them to remove them, he held the photograph in his left hand, so as not to touch the outer coating of the charged jar with which it was connected, and remarked:

"As you see, these colors are arranged so that they can be removed from the photograph." Then proving his words by taking the colors from the picture, but again immediately placing them back on the picture.

"What did you do that for, Tom?" asked the boy. "Don't put it back. Those colors have no right on that photograph."

"That's right," said Tom, handing his victim the photograph. "Take them off then."

The boys crowded around believing that Tom was up to one of his tricks. As soon as the boy who had grasped the photograph, so as to touch the outer coating of the jar, placed his fingers on the colors, he received a fairly severe shock, to his great astonishment, but to the delight of the boys who were looking on.

"That's one on me, Tom," replied the boy, laughing good-naturedly. "You are certainly a great fellow to play tricks. Please explain to me how it was done."

Now, this was something Tom never refused to do. He was always ready to explain to his victims just how he had played the tricks on them, nor did he refuse to permit any who were present to hear this explanation, only asking them to promise not to tell it to any of the boys who were not in the room, since he wished at the first opportunity to try it on them. Of course, Tom never had any difficulty in obtaining the promise he desired. This may not have been entirely by reason of their good nature, but, perhaps, to no little extent, from their desire to see the same trick played on another unfortunate victim.

The next morning, while Tom and Rick were walking to the school, Tom said:

"Rick, why should not you and I repeat Franklin's experiment of drawing electricity from the clouds? What do you say to trying this with me?" asked Tom.

"I should like to do so very much," replied Rick, "but, of course we must not forget that such experiments are very dangerous."

"Yes," was the reply, "I know there is great danger, but I think it will be safe if we are careful."

"Very well," said Rick, "I'll be glad to help you, although it will be mainly your experiment. Before actually trying the experiment, let us spend several days in talking the matter over, reading up all we can about it, and try to find out in just what directions the dangers lie."

"Examinations begin to-day, so we will have lots of time to ourselves during the next two weeks," said Tom.

Yearly examinations had no terrors for either Tom or Rick. They prepared their lessons so intelligently that they never had any trouble in passing their examinations. Indeed, they were not required to take examinations in most of the branches. Their standing, as based on daily recitations during the term, was so excellent that they were excused from taking any other tests whatever, being advanced into the next higher class on recitations alone, or being, as it is called in Philadelphia, as well as in the schools of some other large cities, "exempted."

The boys met in Tom's laboratory early that afternoon, when they began reading different books, containing accounts of Franklin's early experiments. As usual, every now and then one of them would look up from the book he was reading and begin talking to the other about something that particularly interested him.

"Rick," said Tom, on one of these occasions, "I see from this book that Franklin made notes of all his experiments. He afterwards used these notes in the preparation of his letters on electricity, or while writing his scientific papers. That's a capital idea. Let's do this both with our experiments as well as with our readings."

So it was agreed that they would keep an account of all such matters.

The boys then again went on reading their separate books. This time, Rick broke the silence, exclaiming:

"Tom, I wonder how it ever came into Franklin's head to think of trying to draw electricity from the clouds?"

"Listen, Rick," was the reply. "I have just been reading about it. This is what Franklin wrote in his note book." Tom then read as follows:

> "*November* 7, 1749.—Electrical fluid agrees with lightning in these particulars. 1. Giving light. 2. Color of the light. 3. Crooked direction. 4. Swift motion. 5. Being conducted by metals. 6. Crack or noise exploding. 7. Subsisting in water or ice. 8. Rending bodies it passes through. 9. Destroying animals. 10. Melting metals. 11. Firing inflammable substances. 12. Sulphurous smell. The electric fluid is attracted by points. We do not know whether this property is in lightning. But since they agree in all the particulars wherein we can always compare them, is it not probable they agree likewise in this? Let the experiment be made.'"

When Tom reached the last words, "let the experiment be made," Rick exclaimed:

"So say I, Tom. Let the experiment be made by Bronson and Justice."

"That's what we are going to do," replied Tom.

"Come, Tom, let us talk over what we have both been reading about, the manner in which Franklin planned his great experiment."

"It appears," replied Tom, "that Franklin had thought of two plans for drawing electricity from the clouds. The first was to attach a conductor to the outside of a church spire, so that the top of the conductor would project a considerable distance above the top of the spire. In this manner he hoped, when an electrified cloud passed over the spire, that sparks could be taken from its lower end, the charge in the cloud being drawn or attracted to the point in the manner in which he proved that an electric charge is attracted. He was obliged, however, to abandon this idea, for there were then no church spires in Philadelphia."

"No church spires in Philadelphia!" exclaimed Rick in astonishment. "There has been a great change in our city since 1749."

"Franklin," continued Tom, feeling that Rick's remark needed no reply, "then thought of another plan, which was to fly a kite so as to make it enter a thunder cloud, hoping in this way to draw a discharge through the string of the kite from the cloud, down to the ground where he could examine it. Franklin's kite consisted of an ordinary wooden frame on which, instead of paper, a light silk handkerchief was stretched, so as to permit the kite to be employed during rainy weather."

"Go on, please, Tom," said Rick, greatly interested, "tell me how he raised the kite."

"It seems," continued Tom, "that he feared the people would laugh at a man of his age flying a kite, so he took his son along with him."

"Yes," remarked Rick, laughing, "and probably also to give him some points in kite flying, as Franklin had probably lost his skill in this direction."

"Very likely, Rick," said Tom, laughing.

"I have read," said Rick, "that Franklin is believed to have raised this famous kite somewhere in Spring Garden Street, near 18th Street."

"Yes," said Tom, "he raised the kite just before the approach of a thunder storm. When it reached the clouds, he attached a silk ribbon to the end of the string to serve as a non-conductor. But," continued Tom, "I think it will be better if you hear the description of Franklin's experiment which is contained in the book I have been reading." Tom then read as follows:

"'Furnished with this apparatus, on the approach of the storm, he went out upon the commons, near Philadelphia, accompanied by his son, to whom alone he communicated his intentions, well knowing the ridicule which would have attended the report of such an attempt should it prove unsuccessful. Having raised the kite he placed himself under a shed, that the ribbon by which it was held might be kept dry, as it would become a conductor of electricity when wetted by rain, and so fail to afford that protection for which it was provided. A cloud, evidently charged with thunder, soon passed over the kite. He observed the hempen cord; but no bristling of its fibres was apparent such as were wont to take place when it was electrified. He presented his knuckle to the key, but not the smallest spark was perceptible. The agony of his expectation and suspense can be adequately felt by those only who have entered into the spirit of such experimental researches. After the lapse of some time he saw that the fibres of the cord near the key bristled, and stood on end. He presented his knuckle to the key and received a strong bright spark. It was lightning. The discovery was complete, and Franklin felt that he was immortal.'"

"Do you know, Tom," enquired Rick, "when Franklin's experiment was tried?"

"It was sometime in June, 1752," replied Tom.

"Tom," exclaimed Rick, "I remember reading in several books that Franklin was not the first to draw electricity from the clouds. That a Frenchman, named D'Alibard, succeeded in doing this at an earlier date; that is, on the 10th of May, 1752."

"That's right, Rick," replied Tom, "but D'Alibard acknowledges that he got the idea from Franklin. Franklin was far ahead of D'Alibard in this matter. Several years before 1752, Franklin made a number of experiments in which, assuming that lightning flashes are electrical discharges, he showed how charged clouds, that he imitated by charged insulated conductors, could be safely discharged by the use of pointed metallic rods. In other words, Franklin invented lightning rods, several years before he actually drew the lightning from the skies.

"An account of these experiments was published in London in 1751. It was afterwards translated by D'Alibard, into French, and published in Paris. D'Alibard's translation had a large sale in Paris. Coming to the attention of the French court, the King requested that Franklin's experiment be repeated before him. It was, by reason of this request, that D'Alibard had an iron rod forty feet high, placed in the garden of a little village about eighteen miles from Paris. During a thunder storm, on the 10th of May, 1752, he succeeded in drawing electricity from its lower end. But, as you see, this experiment was made at the suggestion of Franklin."

XV.

PREPARATIONS FOR THE GREAT EXPERIMENT OF DRAWING ELECTRICITY FROM THE CLOUDS

On reaching school on Monday morning Tom and Rick showed the principal, Mr. Askinson, the photographs of the tree struck by lightning, of the lightning flashes, as well as the lightning tube. This gentleman was so pleased with what he saw, especially with the photograph of the multiple lightning flash, that he asked permission to exhibit it at the next meeting of one of the scientific societies to which he belonged. Of course, the boys were delighted to do this; for they were proud that their teacher thought the photograph of sufficient importance to show to an assembly of scientific men.

The boys met early Tuesday morning in Tom's laboratory. Although they had now carefully read all they could find about the manner in which Franklin prepared his great experiment of drawing electricity from the clouds, yet they determined, before attempting to repeat the experiment to carefully study some of the experiments made by others in imitation of the great Philadelphia philosopher.

"In this way," said Tom to Rick, "we can find out a lot and get a better idea of the dangers. I say," he continued, "didn't Mr. Askinson seem pleased with what we showed him yesterday?"

"Yes," replied Rick, "he was very much pleased. Tom," he continued, "let's show these pictures to Mr. Alexander the next time we go to the electric lighting station. He is so well up on electricity that they may interest him."

"That's a good idea, Rick," was the reply.

Before getting to work, Tom said to Rick:

"Now, Rick, we must not forget that this experiment is very dangerous. But if we are careful, I feel sure that nothing serious will happen. Now, let us find exactly how Franklin made his kite. Here is a description, by Franklin himself, taken from a letter, dated, Oct. 19th, 1782." Tom then commenced reading as follows:

"'As frequent mention is made in public papers from Europe of the success of the Philadelphia experiment for drawing the electric fire from the clouds by means of pointed rods erected on high buildings, etc., it may be agreeable to the curious to be informed that the same experiment has succeeded in Philadelphia, though made in a different and more easy manner, which is as follows:

"'Make a small cross of two light strips of cedar, the arms so long as to reach to the four corners of a large silk handkerchief when extended; tie the corners of the handkerchief to the extremities of the cross, so you have the body of a kite, which being properly accommodated with a tail, loop, and string, will rise in the air, like those made of paper, but this being of silk, is fitted to bear the wet and wind of a thunder-gust without tearing. To the top of the upright stick of the cross is to be fixed a very sharp pointed wire, rising a foot or more above the wood. To the end of the twine next the hand, is to be tied a silk ribbon, and where the silk and twine join, a key may be fastened. This kite is to be raised when a thunder-gust appears to be coming on, and the person who holds the string must stand within a door or window, or under some cover, so that the silk ribbon may not be wet; and care must be taken that the twine does not touch the frame of the door or window. As soon as any of the thunder clouds come over the kite, the pointed wire will draw the electric fire from them, and the kite, with all the twine will be electrified, and then loose filaments of the twine will stand out in every way, and be attracted by an approaching finger. And when the rain has wet the kite and twine so that it can conduct the electric fire freely, you will find it streams out plentifully from the key on the approach of your knuckle. At this key the phial may be charged; and from the electric fire thus obtained, spirits may be kindled, and all the other electric experiments be performed, which are usually done by the help of a rubbed glass globe or tube, and thereby the sameness of the electric matter with that of lightning completely demonstrated.' "

When the boys finished reading this description they commenced as usual talking about it.

"Tom," said Rick, "the two sticks of cedar were of the same length, is that the way you understand it?"

"Yes," replied Tom, "for you remember that their ends reached to the four corners of the silk handkerchief. Well there will be no trouble in making the kite, or in fitting a piece of wire to the middle stick, so as to make it project above the top."

"You see, Tom," remarked Rick, "when the kite reached the proper height, a key was suspended to the end of the kite string and a piece of silk ribbon was tied to the end of the string to insulate the kite. Do you understand that as soon as the silk ribbon was attached to the kite string, Franklin secured the end of the ribbon to some suitable support connected with the ground?"

"I am not sure," replied Tom. "Franklin says in his description of the kite, 'the person who holds the string must stand within a door or window, or under some cover, so that the silk ribbon may not be wet,' but this may only mean until the silk has been attached to some suitable support. It seems to me that it would have been dangerous for Franklin to have held the kite even by the silk ribbon. Moreover, if he held it in his hand, he would not have been able to make the different experiments he refers to with the electric sparks he drew from the key."

"But," said Rick, "how did he keep from being struck by the flash while he was raising the kite, and, therefore, while he had hold of the kite string?"

"I suppose," replied Tom, "he took this risk, probably raising the kite long before the thunder storm came on. But whether or not Franklin took the precaution of not holding the kite string in his hand during the storm, we will certainly attach the silk ribbon to a support, and thus avoid much of the danger."

As soon as they finished talking about Franklin's kite, Tom began reading about another kite that was raised on the 7th of June, 1753, by a Frenchman, named DeRomas. This kite was much larger than Franklin's, being 7½ feet high, 3 feet wide, with a total wind surface of some eighteen feet. DeRomas greatly improved the conducting power of the string employed for raising his kite, by interweaving a fine wire between its threads.

When his kite reached the height of about 500 feet, DeRomas insulated the end of his conducting kite string, and attached it to a firm support in the ground. He then connected the end of the kite string to a large insulated tin tube, which took the place of the key in Franklin's experiment. During a thunder storm DeRomas succeeded in drawing electric sparks, three inches in length and a quarter of an inch thick, from the tin tube. As each spark jumped across the air space, between the tin tube and an earth-connected conductor placed near it, loud reports were produced that could be heard at a distance of several hundred paces.

When Tom came to the statement that on one occasion, while experimenting with the kite, DeRomas felt as if one was rubbing cobwebs over his face, he said:

"Rick, that's the way you felt in the Park, when we were under the tree. Listen," he continued, "DeRomas did just what we did; for, after shouting to the people to get away from the tube he ran away from it, when almost immediately afterwards, three flashes, rapidly following one another, passed between the tube and the ground with a noise resembling thunder."

"In order to know when the tube was charged, DeRomas had suspended three straws from it. As soon as a charge passed into the tube from the kite along the string, the straws at the ends of the tube stood out straight from the tube just as the hair did on your head, Rick, the other day in this room."

"Tom," said Rick, "I wonder whether DeRomas thought of examining the ground below the tube where the charge entered to see if a lightning tube was formed?"

"Nothing was said about such a thing," replied Tom, "so I guess it was not done."

"Now," said Rick, "I think that's enough about kites. Let's see if we can find a description of experiments in which electricity was drawn from the clouds by conductors attached to the tops of tall objects, so as to extend a great distance upwards in the air."

"There are many accounts of such conductors," replied Tom. "On the 6th of August, 1753, almost exactly one month after the experiment by DeRomas, Prof. Richmann, of St. Petersburg, while drawing electricity from the clouds, was instantly killed. Richmann had fixed to the side of his laboratory building an iron rod projecting above the roof. An insulated metallic chain connected the rod with an insulated metallic rod that projected vertically downwards a short distance below the ceiling of the laboratory, where it terminated in a smooth metallic ball. As soon as any electricity passed from the clouds down to the rod, a small thread hung to the rod so as to touch the ball stood out, thus indicating a charge.

"One day, while Prof. Richmann and a friend were in the laboratory, in order to more carefully observe the movements produced on the string by a charged cloud, Richmann imprudently brought his head near the ball. Suddenly, a ball of fire, about the size of his fist, jumped from the ball, and struck him on the head. He was in-instantly killed by the discharge, and his friend, who was standing near, was knocked senseless and did not regain consciousness until some time afterwards."

"I wonder," said Rick, "if Richmann did not have the cobweb feeling when he brought his head near the ball. If he did and noted the warning, he might have saved his life."

"It is almost certain that he had such a warning, Rick. When we try our experiment we must be careful to watch for the first appearance of the cobweb feeling, and instantly draw away from the conductor connected with the string of the kite."

"Must the wire be raised very high in the air in order to draw electricity from the clouds?" enquired Rick.

"No, I remember reading of a experiment in which by simply attaching a wire to the end of a fishing pole, the other end being attached to a gold-leaf electroscope, the leaves were caused to fly apart when the rod was merely raised in the air."

"Well, that's one experiment we can try," said Rick.

"Another simple experiment," said Tom, "was made by Becquerel and Breschet, on the top of the Great St. Bernard, a mountain in the Alps, by shooting into the air, arrows attached by a tinsel cord to an apparatus resembling our gold-leaf electroscope. The higher the arrows rose in the air, the further the gold-leaves moved apart.

"But," continued Tom, "even horizontal wires stretched above the tops of tall trees will sometimes bring down powerful discharges from the air. An Englishman, named Crosse, erected about sixteen hundred feet of wire on poles reaching high above the tops of the tallest trees in his park. This wire was connected by means of a conductor with his laboratory, where it was in turn connected to a carefully insulated metallic ball suspended from the ceiling and placed near another ball connected with a powerful Leyden-jar battery.

"Crosse obtained some wonderful discharges from this wire. He says that on a cold November afternoon, during a dense fog and a rain storm, he saw a number of electric discharges pass between the two balls. At each passage of the discharge, a noise was heard not unlike peals of thunder. At times these discharges followed one another so rapidly that there was an almost continuous stream of fire between the two balls. These discharges continued for nearly five hours, accompanied by an almost deafening roar, with only occasionally quiet intervals.

"Besides these experiments," continued Tom, "on July 20th, 1752, an Englishman, named Canton, repeated Franklin's experiment of drawing electricity from the clouds. His apparatus was very simple. It consisted of a tin tube, three feet in length, insulated by being placed in the open top of a glass tube. This tube was connected with a wire extending above the chimney of the house, the lower end of the tin tube being provided with a cover in order to keep the glass tube dry. Applying the knuckle of one of his hands to the edge of the cover, during a thunder storm, Canton was able to draw electrical sparks from it.

"On the 12th of August, 1752," continued Tom, "another Englishman, named Wilson, drew electricity from the clouds by means of still simpler apparatus. This consisted of a short iron curtain rod, insulated by inserting it in the mouth of a glass bottle held in his hand. By merely holding this apparatus in one hand, Wilson was able to draw electric sparks from the lower end, when he approached the knuckle of the other hand to it, these sparks being sufficiently powerful to produce a snapping sound as they passed through the air. But what is remarkable about this experiment is the fact that when Mr. Wilson tried this experiment he was not on an elevation, but in the garden."

Rick was very enthusiastic when Tom related this experiment.

"If it is as easy as that, Tom, it will be strange if we don't succeed in getting some electricity from the air."

"Yes, Rick," replied Tom. "I have no doubt, but that we shall succeed in getting something. But listen to this, Rick," he continued, "here is an even simpler experiment. A man, named Monnier, by means of a silk string, suspended a small tin speaking trumpet only five or six feet above the surface of the ground, and found that during stormy weather, he could readily obtain fairly strong signs of electricity from the trumpet."

"Tom," said Rick, "I understand that, long before Franklin's time, several writers suggested that lightning flashes so resembled electric discharges that the two were probably produced by the same causes.

"Yes," replied Tom, "that is so, but Franklin was the first to prove their identity."

"Were these the very earliest, Tom?" enquired Rick, after Tom had mentioned two or three.

"No," replied Tom, "some think that the fabled Prometheus was the first man to actually draw electricity from the clouds. Have you ever heard of Prometheus?" enquired Tom.

"Yes," replied Rick, "I have heard of him. "He is said to have been brighter and more cunning than the other fellows. But he was so stuck on himself that he ventured to ridicule Jupiter. In order to punish mankind, and especially Prometheus, for a lack of reverence, Jupiter took away fire from the earth, but, Prometheus, aided by Minerva, the Goddess of Wisdom, climbed to the heavens and stole the sacred fire from the chariot of the sun. As a punishment for this impious act, Jupiter caused Prometheus to be chained to a rock on Mt. Caucasus, where, for more than 30,000 years, a vulture fed on his liver, the liver being miraculously caused by Jupiter to grow as fast as it was consumed. At the end of this long period, Hercules, in pity, delivered Prometheus from the punishment."

When he had finished his story, Rick added:

"How is that for batting them out, Tom?"

"You are well up on Prometheus, Rick," said Tom, laughing. "Now it has been claimed by some, that what Prometheus really did was to draw electricity from the clouds and so light fires. This may or may not have been true, but I believe that it is not generally credited. But Prometheus is not the only one for whom this great feat has been claimed. It is said that Numa Pompilius, a Roman, succeeded, on several occasions, in safely drawing the sacred fire from heaven; and that another Roman, Tullus Hostilius, got hold of some notes left by Pompilius, giving directions as to how to employ the sacred art of worshipping Jupiter. Not fully understanding these directions, Hostilius attempted to repeat the sacred rites, and was instantly killed by the angry Jupiter."

"Now, Rick," said Tom, "read me your notes. I want to refresh my memory."

Rick then read as follows:

"November 7th, 1749.—Franklin enters, in a minute book, his reasons for believing that electricity and lightning are produced by the same causes, and suggests that an experiment be made to determine whether the lightning in a cloud would be acted on by points in the same way that electricity would in a charged conductor.

"In a letter to his friend Collinson, dated July 29th, 1749, Franklin describes a number of electrical experiments he made in Philadelphia, in 1749, respecting the discharge of electricty from artificial clouds, describing his invention of a rod to be placed on the sides of houses, to protect them from lightning flashes. This letter, published in England, in 1751, was subsequently translated into French, by a Frenchman, named D'Alibard, who succeeded, in 1752, in drawing electricity from the air, by means of an iron rod, some forty feet high, erected in a garden in a village named Marly-la-Ville, eighteen miles from Paris.

"June 7th, 1753, DeRomas, a Frenchman, raises a kite in the air and obtains powerful electric discharges from an insulated tin tube connected by a conducting wire to the lower end of the kite string.

"August 6th, 1753, Prof. Richmann, of St. Petersburg, was instantly killed by a lightning bolt, passing from the end of an insulated conductor connected with the lower end of a wire that extended above the roof of his laboratory.

"Various simple experiments for obtaining free electricity from a wire raised in the air from the top of a fishing rod to which it was attached; from a piece of iron curtain rod, supported vertically in the air from the open mouth of a glass bottle; from arrows shot into the air from bows, and from a small speaking tube, suspended by silk threads, a few feet above the ground.

"Crosse, of England, by means of a horizontal wire suspended by means of insulators from poles projecting above the tops of the highest trees in his park, draws from the air, an almost continuous succession of sparks accompanied by almost deafening reports.

"July 20th, 1752, an Englishman, named Canton, draws electricity from the air and employs a chime of electric bells in order to notify him when his apparatus is charged with free electricity.

"Suggestions were made at various dates long before Franklin's time, as to the probable identity between electrical discharges and lightning."

"Long before any of the above, it is claimed by some that Prometheus, Numa Pompilius, and Tullus Hostilius, succeeded in drawing down the sacred fire from heaven, or, as it is alleged, obtaining lightning flashes from the sky."

"Bravo, Rick. They are capital notes that you have just read. I see that you have added some facts that I have not read to you, and that you have probably added from your own reading."

"Yes," replied Rick, "I have added a few facts from my general reading."

XVI.

TOM AND RICK REPEAT FRANKLIN'S EXPERIMENT OF DRAWING ELECTRICITY FROM THE CLOUDS

When the boys went to the grammar school on Wednesday, they were pleased to learn that Thursday was the only other day that week on which they would be obliged to take examinations. This gave them Friday and Saturday for the proposed experiment. They arranged, therefore, to spend all Friday in making their kite and in getting together whatever other apparatus they might need, so that they would be ready to raise the kite, and sample a thunder cloud, on Saturday, should there be a thunder storm on that day.

On reaching the laboratory on Friday morning, they at once began making the kite. Not being familiar with the form of kite used by Franklin, with a frame of two wooden sticks of the same length, they very sensibly determined to use a vertical stick about one and three-quarters times the length of the cross stick. They made the sticks of slender pieces of strong hickory. Instead of employing a silk handkerchief for covering the frame, they used a piece of thin silk that had been left over after the making of a dress for Rick's mother. A piece of thin copper wire, securely fixed to the vertical stick of the kite so as to project a few inches above its upper end, was connected with the string employed for raising the kite. A loop of string, of a length somewhat greater than the length of the cross stick, had its ends connected to the ends of the cross piece, while a second piece of string atached at one end to the top of the vertical stick, and at the other end to the middle of the loop, was provided for holding the end of the raising string, this end being attached near its middle. In this way the point of support of the kite came at equal distances from the ends of the horizontal cross piece, and a short distance from the point where the two pieces of wood crossed each other. The tail of the kite was made in the usual manner, and consisted of a piece of strong string attached to the end of the vertical cross piece and properly weighted by a number of little rolls of paper tied across it at equal distances apart.

There had been no little argument between the two boys whether an ordinary hempen cord should be employed alone for raising the kite, or whether they should improve its conducting power by interweaving a thin copper wire between its strands as was done by DeRomas.

"The wire will make it conduct better," argued Rick, "and so let any electricity it may get from the kite to pass more easily down the string."

"True," replied Tom, "but it would make the weight of the string so great that it would be hard to raise the kite unless the wind was high. I guess this was the reason DeRomas built so large a kite."

"All right, then," replied Rick. "We'll use the simple hempen cord."

"I think it will be better," replied Tom. "Anyhow, we don't wish to obtain very powerful discharges. I'll be satisfied if we get only a few sparks with loud reports."

The kite was completed about eleven o'clock, that morning. Tom proposed they should go to the Park and endeavor to raise it, not for the purpose of obtaining electrical discharges from the air, but merely to see whether it was properly balanced. They therefore went to the great East Park Reservoir that extends on 33d Street, between Columbia Avenue and Diamond Street, west almost to the Schuylkill River. This reservoir is provided with a broad asphalt walk or pavement extending completely around the top of the embankment. From this walk an excellent view can be had on the north of the Strawberry Mansion Lawn Tennis Courts, and the Edgley Ball Fields, and on the west, of the Athletic Field at the Dairy. It is, therefore, a favorite resort for pedestrians who care to look at athletic sports from a distance.

A strong summer breeze was blowing from the southwest, so they took their kite to the portion of the walk facing 33rd Street and soon succeeded in raising it.

It was fortunate they had taken the precaution of testing the kite before employing it in their experiment. On the first trial, it behaved in a very unsatisfactory manner, pitching violently and frequently falling to the earth. At last, however, after repeated changes in the length of the cross-loop, as well as in the length and weight of the tail, they greatly improved its behavior. But neither Tom nor Rick was entirely satisfied, and they were about to pull it in to make another change when Ralph Coffin approached and commenced chaffing them, saying:

"Hello, boys, gone back to kite flying? I wouldn't have thought it possible that the Honorable President, and the Distinguished Chemist, of the Ancient and Honorable Society of the Jolly Philosophers, would condescend to fly a kite in this public manner. I wonder what the other members would say if they saw you?"

"I don't know, and I don't care," replied Tom, winking at Ralph. "I would not be surprised, however, if the members are the sensible fellows I think they are, that they would not only be pleased but also proud when they heard of the very scientific experiment their President and Chemist are about to try."

"Hello," exclaimed Ralph, "then this is not an everyday kite flying that I am witnessing. Something in the scientific line?" he enquired.

"Yes," said Tom, "very much in that line."

"What are you and Rick up to?" asked Ralph. "Or would you rather not tell?" he added, politely. "If so, I can wait, for I am pretty sure you will be successful."

"Shall I tell him?" enquired Tom, turning to his colleague.

"Certainly tell him," replied Rick. "Only," he said, turning to Ralph, "please be sure you don't say anything about our experiment until we try it. We don't want to have it talked about either at school or at the Society. There will be time enough to talk about it if we are successful."

"All right," said Ralph, "I promise. But don't tell me if you would rather not."

"That's all right, Ralph," replied Tom. "We intend trying to repeat Franklin's experiment of drawing electricity from the clouds. It is for this that we have made the kite you see and are trying it, so as to get it all right for the experiment."

"Well, that's good," said Ralph. "Perhaps I can help you. I used to be as well up in kite flying as most of the boys in our New England town and that is saying a great deal; for, these boys are great on kite flying."

"Glad to have any points you can give us, Ralph," replied Tom. "We have the kite in better shape than it was sometime ago, but are not satisfied with it yet."

Ralph silently looked at the kite with a critical eye for at least five minutes. At last he said:

"You want to make the length of the loop to which the cross string is attached a little shorter. The kite is not supported at the right centre." And then he added: "The tail should be longer. I would not increase its weight, but would merely make it a little longer by lengthening the string and placing the cross pieces of paper further apart."

"All right," replied Tom, "we will try these changes."

Pulling down the kite they made the changes Ralph had suggested, and on again raising the kite they found a very marked improvement in its behavior. It now rose readily in the air, and, moreover, remained much quieter.

"Bully for you, Ralph," said the boys. "You are all right on kite flying."

"May I help you get ready, and then come and see this great experiment?" asked Ralph. "I'll do what you tell me to do, will charge you nothing, and will work overtime."

The boys agreed to let Ralph help them, and be present when the experiment was tried. At the same time they told him that drawing electricity from the clouds was a dangerous trick. If he was willing to take his chances he might accompany them. As Tom was drawing the string in and Ralph was winding it on a stick, Tom said to Rick:

"We must determine this afternoon how best to secure the silk ribbon at the end of the raising string to a suitable support on the ground. We must also get together the apparatus we'll take with us in order to test any sparks we may be able to draw from the clouds."

After carefully discussing the character of the conductor that was to be attached to the end of the kite string as soon as they succeeded in raising it, they concluded to use a hollow cylinder of brass about twelve inches long, and an inch and a half wide, supported in a horizontal position on the end of a vulcanite rod, about two feet in length. The cylinder was provided at each end with two pith balls suspended by linen threads.

"Now, we must contrive means for firmly attaching the cylinder to the ground, so as to hold the kite," said Tom. "This support should be strong, for you know how hard a kite pulls when the wind is high. We must also have a cover for protecting the support from the rain."

After much consultation they determined to attach the kite to the earth by employing a stout hickory rod driven into the ground, rigidly fixing the top of the rod to the bottom of the vulcanite by means of a screw joint.

Tom now selected a piece of good, strong, dry hickory and went to his lathe to cut screw threads on the end of the two rods.

"You see," he said to Rick, "when we reach the place where we are to fly the kite, we will drive the hickory rod into the ground and then screw the vulcanite rod on it. While I am getting the hickory rod ready suppose you see about making a cylindrical cover of pasteboard, with a slanting top, big enough to readily surround the two rods. In order to keep the rain from soaking through it, we will cover the pasteboard with melted paraffine. The pasteboard cover will look something like this," said Tom, making a rapid pencil sketch of the device.

"Let me help you, Tom," said Ralph. "Shall I turn that piece of hickory and cut a screw at its end? I am accustomed to lathe work both in wood and in metal."

"All right, Ralph," said Tom. "We've plenty to do to be able to start at an early hour to-morrow. Go on and turn the hickory rod, and Rick and I will get the other things ready."

Although Tom promptly accepted Ralph's offer to work at his lathe, he kept his eye on the tool for sometime; for, the lathe was the pride of his laboratory, and he never permitted any one to use it, unless he knew just how to handle it. It did not take Tom long, however, to see that Ralph was, if anything, a better workman than himself, so he left him and went on getting the other parts ready.

It took much longer to complete the apparatus than the boys had expected, for supper time came with the work still unfinished. They were, however, so much interested in the work that they agreed to return after supper and finish it.

When, at last, everything was finished, and all the apparatus selected they intended to take with them, the laboratory was shut up. They agreed to leave the next morning as soon after breakfast as possible. Since they expected to remain out the entire day they planned to take their lunch with them.

As the boys went home that night there was one thing that greatly troubled them. Everything was now ready for the great experiment, but suppose the day should break clear, and there should be no thunder storm! But worrying never helps one, so being good philosophers, they bid each other good night and went home hoping for the best.

The next day broke provokingly clear. There was not a cloud to be seen either directly overhead or on the horizon. It did not seem as though a thunder storm was at all probable. As Rick, looking at the clear sky, began to express his dissatisfaction, Tom said:

"Come, Rick, don't grumble and grunt so. The day is young yet. You can't tell what may happen before night. Remember it doesn't take long at this time of the year to have great changes in the weather."

"Where will you try this experiment, Tom?" enquired Ralph. "On the Reservoir?"

"No, that would never do," replied Tom. "We wish to be as nearly alone as possible during this experiment. If we tried it in such a public place as the Reservoir, there would soon be a crowd around us. We will, therefore, look for some retired place in the Park, on one of the high hills overlooking the River. Here we will drive in the hickory stake for the support of our conductor, and wait for the storm we hope will come. And even if it doesn't come we can have a good time either lying on the grass talking, or with our baseball and bats."

They formed an odd looking party as they walked at an early hour next morning to the Park. Rick carried in one hand a fishing pole and a bow and arrows, and in the other the kite, the silk covering of which, as well as the wire projecting above the vertical cross-sticks, made it look unlike an ordinary kite, and therefore attracted no little attention from the people they passed. Tom carried the pasteboard covering and the hickory stick together with a number of baseball bats, while Ralph was loaded with a heavy grip packed with the different things they needed for their experiment. In addition to these, each carried a rubber raincoat as well as a good-sized package of lunch.

When they came to the Dauphin Street entrance to the Park, Rang, the good-natured Park guard, No. 61, stationed at that entrance, exclaimed as they approached:

"Out for a jolly day, boys?" and then looking at the curious things they were carrying, he continued: "I thought I could guess what you were up to, but that strange looking kite, your fishing pole, bows and arrows, baseball, bats, and raincoats make me unwilling to guess. I'll bet, however, you are out for a good time," and then looking at their raincoats, he added to their great disgust: "I don't think you will need your raincoats, boys, it doesn't look at all like rain. Wouldn't you like to leave them in my sentry box? I will take good care of them for you until you return."

"No, thank you," said the boys, "we'll take them with us."

As soon as they were out of hearing, Rick remarked in a grumbling tone:

"I'm afraid he's right, there doesn't seem to be much chance for rain to-day."

"Now, don't be a Jonah, Rick," said Tom, "there are many hours between now and sunset. A big storm may come before the day is over. I am sure it is hot enough."

The boys entered the Park, approaching the northeast corner of the Edgley ball field, where they had played the match game of ball already referred to. As they were passing the baseball diamond at this corner of the field, one of a crowd of boys, who were holding it until the arrival of the rest of their team, as soon as he saw Tom, shouted with delight:

"There's Tom Bronson," and then shouting to Tom, he said: "Come, Tom, and give me a few inshoots. We are going to play a match game of ball and I want to get my hand in."

"I can't to-day," replied Tom. "I have an engagement elsewhere."

As the boy looked at the kite and fishing pole, and the strange things they were carrying, he said, somewhat contemptuously:

"So you are going kite flying and fishing are you, just like a lot of little kids. I didn't think you'd be up to such a thing." But then seeing the baseball bats for the first time, he said: "Oh, it ain't as bad as I thought it was; you have a few baseball bats with you. Well, then, so long," he cried, as the boys left him.

Turning to the north the boys descended the hill, crossed the Park trolley track, and climbing the high steps were soon in the grounds that surround Strawberry Mansion, which they crossed, and went over the trolley bridge to the western bank of the Schuylkill.

As the day was warm, and they were laden with their bundles, they proceeded at a slow gait towards the Speedway, from which they made their way along the western bank of the Schuylkill, and selected a retired spot, on the top of a hill, at some little distance from Chamounix. Here a fine view of the river could be had, so they collected a few of the Park benches under the shade of a large tree, and placed their bundles on them.

It was now about 10.30 A.M. There were no signs of rain. Scarcely a breath of air was stirring. Raising a kite during such weather was out of the question, so, after driving the hickory stake in position near the top of the hill, they got out their baseball and bats and commenced practicing batting and catching. It was, however, so hot that an hour of this exercise satisfied them. They, therefore, laid down in the grass to cool off, and then ate their lunch, from which, as is well known, not even the hottest weather can drive away a healthy boy. After lunch they again lay down in the grass under a tree and began talking about the different books they had been reading.

Although there were no signs of a storm, yet they concluded after awhile to try the experiment with the arrows.

Tying an arrow to one of the ends of a tinsel cord, the other end of which was connected to a gold-leaf electroscope, they shot the arrow from the bow high into the air, and were pleased to find that the gold leaves moved further and further apart as the arrow rose higher and higher. Although the experiment was successful, yet they were not quite satisfied, since, as Tom said:

"The electricity may not have been the free electricity of the air, but due to the friction of the arrow against the air as it moved upwards."

Near two o'clock a few clouds began to appear in the sky, so they screwed the vulcanite rod and brass conductors to the hickory stake, and placed the rain cover around it. They were thus ready should a storm arise.

"Let's try the fishing pole," Tom said.

Clouds were beginning to collect in the sky and the wind was beginning to blow.

Attaching a copper wire to the pole so that its upper end extended above the top, they connected the lower end to the gold-leaf electroscope, and were delighted to find that when the wire was raised in the air by lifting the pole, the gold leaves were violently repelled.

Towards half-past three, to their great delight, a mass of dark clouds was seen collecting in the west. From the top of this mass a number of thunder-heads were slowly rising. A storm was evidently coming, so they at once made preparations for raising the kite. As soon as this was done they attached a piece of silk ribbon to the kite string and the end of the ribbon to the vulcanite rod. At the same time they connected the end of the kite string by means of a wire to the brass cylinder.

The approaching storm now came nearer. Distant thunder was heard, and every now and then a flash of lightning was seen lighting up the western sky. Knowing from experience that the rain would soon fall, they put on their raincoats and waited with joy the rapidly coming storm.

As the storm came still nearer, they were delighted to see the pith balls, at the end of the brass cylinder, stand straight out from the metal, thus showing that the cylinder had collected a charge of electricity from the kite.

"I think," said Tom, "it will be safe to take that discharge." He, therefore, approached one of the ends of the brass cylinder with a brass ball attached to a conducting wire, insulated from his hands by means of a vulcanite rod, but connected with the ground at the other end. A series of short sparks passed between the brass ball and the cylinder. Convinced that the discharge could be safely taken, Tom now charged a Leyden jar with the sparks and then employed this jar for ringing a chime of bells they had brought with them for this purpose. This greatly excited them; for, they had in this way repeated Franklin's great experiment.

While standing near the insulated cylinder, they all suddenly felt the cobweb feeling in their faces.

"The charge is becoming dangerous," cried Tom. "Let's get away from here quickly before any accident happens."

They, therefore, ran rapidly away from the conductor and stood at a safe distance watching it eagerly. The storm was now nearly overhead. Frequently lightning flashes were seen in the heavens followed by almost deafening peals of thunder. The fall of rain increased. The pith balls on the cylinder were violently repelled, showing that the cylinder was receiving a heavy charge, and at last a discharge passed between the end of the cylinder and

A DISCHARGE JUMPED FROM THE CYLINDER TO THE GROUND WITH A REPORT EQUAL TO THAT OF THUNDER

the brass ball connected with the ground. This spark was so great as to produce a loud report as it passed through the air.

"Hurrah!" cried Ralph. "Three cheers for Tom Bronson and Rick Justice. Boys, this is great; I congratulate you."

As the storm came still nearer the discharges between the cylinder and the brass ball increased in intensity, and followed one another more and more rapidly. The noises produced became louder, until at last the discharges between the clouds and the cylinder were almost continuous, the reports becoming nearly equal to those caused by the discharge of large guns.

At this time, two gentlemen, who had taken shelter under a tree when the storm began, and had afterwards, as it increased in severity, left the shelter of the tree, preferring the storm to the risk of receiving a stroke, attracted by the noise, came over to see for themselves what was going on in the neighborhood of the three boys. They approached at the moment the discharge had become almost continuous, and the accompanying roar nearly deafening. Just before they reached the boys the discharge received became so great that the rather slight metallic rod they had used for the support of the brass ball was melted and fell to the ground.

Seeing this, Tom cried to the boys to get further away from the conductor, saying that it might now discharge to the earth. Nor was he mistaken. Before they were far from the insulated conductor, a discharge of a greater volume than any they had observed, jumped from the cylinder to the ground with a report equal to that of thunder.

The two gentlemen now commenced to walk rapidly towards the boys, although they were still too far off to recognize them.

"Alexander," said one of them to his companion, "what in the world are those youngsters doing?" Then seeing the raised kite with the end of string connected to the brass cylinder, he enquired: "Can it be possible that boys so young have been so foolhardy as to attempt Franklin's experiment of drawing electricity from the clouds?"

"It looks like it, Dodge," replied his companion. "But let's get nearer and see for ourselves."

As they approached more closely the gentleman named Alexander recognized Tom and Rick as the boys he had met in the Park on the morning of the ball game, and had afterwards taken through the electric lighting station.

"Hello," said Mr. Alexander, approaching them, "it is Tom, Rick, and another boy. What are you up to, Tom?" he continued. "Do you understand what a dangerous experiment you have just tried? All of you might have been instantly killed."

"Good afternoon, Mr. Alexander. Yes," he continued, "I think we understand the dangers and are trying to avoid them."

The storm was rapidly passing over and soon entirely ceased.

Turning to his friend, Mr. Alexander said:

"Dodge, let me introduce to you two of my boy friends. They are the two boys I was telling you about, who stopped the runaway, and visited our electric lighting station lately. From what you have seen I need not tell you that they are scientific and greatly inclined towards the study of electricity. Introduce us to your other friend, Tom," looking towards Ralph, "I see that he is also scientific."

Tom readily introduced Ralph to the gentleman.

"Boys," said Mr. Alexander, "let me introduce to you, my friend, Mr. John P. Dodge, chief electrician at one of the great electric power stations in the city. If you can persuade him to invite you to visit his station, you will have a chance of seeing electricity produced on a much larger scale than in the little electric lighting station I showed you the other day."

"I am pleased to become acquainted with you boys," said Mr. Dodge. "Come to our power station," then giving his address, "some afternoon when I am disengaged, and I will show you over the place. Better first call me up on the 'phone to see whether I am busy or not."

When Mr. Alexander and Mr. Dodge saw the fishing pole and the bow and arrows and learned the use to which the boys had put them, they laughed and said to each other in a tone that could not be heard by any of the boys:

"Quite scientific youngsters, aren't they?"

"They are, indeed," replied Alexander, to his friend, "unless I am greatly mistaken, they are embryonic electricians of no small promise. We must get better acquainted with them so as to help them in their studies."

"All right," said Mr. Dodge, good-naturedly, "but unless you can persuade them not to try such dangerous experiments, I fear that they may not live long enough to make much progress."

The boys now commenced pulling in their kite and packing up their apparatus, getting ready to return home.

"I will walk to the car with you, boys," said Mr. Alexander, "for I suppose you will take the Park trolley car home."

XVII.

FIVE BOYS AND THE FOURTH OF JULY

As Mr. Alexander and Mr. Dodge were walking with the boys to the trolley car they enquired whether they had been trying any other experiments in electricity than those they had seen that afternoon.

"You tell them, Tom," said Rick. "You can explain better than I can."

Tom, therefore, began describing their recent experiences during the thunder storm in the Park, of the lightning tube, and of the photographs of the lightning flashes.

"Where did you take those photographs, Tom?" asked Mr. Alexander.

"In my laboratory," replied Tom. "At least," he added, seeing the smile that broke out on the other gentleman's face, "I call it my laboratory." And then Tom explained how he occupied the upper floor of a carpenter shop that stood back of the house in which he lived with his mother and younger brother.

"Tell me about the photographs of the lightning flashes, Tom," replied Mr. Alexander.

When Tom described the photographs of the multiple flash, Mr. Alexander was very interested and said:

"I should like to see these photographs, as well as to take a look at your laboratory. If you expect to be there next Monday week, July 9th, in the afternoon, say at four o'clock, I would like to call on you."

Tom was greatly pleased that a man like Mr. Alexander would take the trouble to call on him, and he said:

"I will be there, sir, and will be pleased to have you call. But can I not save you the trouble by bringing the photographs to your office at the lighting station?"

"No, Tom," replied Mr. Alexander, laughing, "I want to see the laboratory also, so I think I will come."

"And may I come also?" said Mr. Dodge to Tom.

"Very glad to have you do so, sir," said Tom.

As they continued walking towards the trolley car, Mr. Alexander said:

"Now, boys, don't think I wish to find fault with you, but I don't believe you understand what a very dangerous experiment you tried this afternoon. I understand from what you have told me that you have taken all the precautions you could to avoid the dangers, but, when you are dealing with such things as powerful lightning flashes, dangers may arise that you would not think of. Indeed, you might all have been killed instantly. Now, while I like to see you try scientific experiments, and believe you are thoroughly capable of taking care of yourselves in most experiments, yet I would earnestly advise you as your friend, and I wish you to look on me as your friend, never to try such an experiment again; for, in it you are dealing with forces far too powerful for boys to handle. I do not think you are justified in taking chances of being instantly killed for the sake of merely repeating experiments that have already been tried. When you grow older it may be different."

The boys listened respectfully to what Mr. Alexander said to them, and then Tom said:

"Mr. Alexander, I am the one most to blame for making this experiment, for I first suggested it. For my part, and I believe the other boys feel as I do, I see now that we have acted foolishly. None of us, however, for a moment thought we would succeed in drawing such tremendous lightning charges from the clouds. Of course, we knew there were dangers, but we carefully read all the accounts we could find of similar experiments, so as to see in what the dangers consisted and tried to avoid them as far as possible."

"I am glad you feel that way, Tom," said Mr. Alexander. "I suppose you don't intend to try to fly any more kites during electric storms, or to make any other experiments of this kind?"

"No, sir," replied Tom, "I promise not to repeat such experiments. At least," he said, correcting himself, "until I first talk about them either with you, or with some other grown person."

"That's right, Tom," said Mr. Alexander, "I am sure that having made such a promise you will keep it."

The trolley car they were expecting to take was now seen coming around a curve in the road, so Mr. Alexander bid the boys good-bye, saying:

"Boys, you've had a splendid day, and have done something you will probably never forget. Remember, we are coming to your laboratory to see you."

"I'll remember," said Tom. "I will look for you Monday next, July 9th, at four o'clock," giving him the address again.

"And, Tom," said Mr. Dodge, just before the car started off, "if I shouldn't come to the laboratory next Monday, don't forget to call on me at the power station."

As the trolley car carried the boys rapidly towards the Dauphin Street entrance to the Park, Tom said:

"I guess, from the serious way in which Mr. Alexander spoke, we were wrong in taking chances while making our experiments. Although we read accounts of the powerful charges obtained by DeRomas, Richmann, and others, I don't believe any of us ever thought we would be able to draw such a lot of electricity from the clouds."

"All right, Tom," said Rick laughing, "now we'll be good, and never do it again."

"I want to take my share of the blame," said Ralph. "Of course, I never thought you would get any more than a few small sparks from the clouds. But it was a great experiment," he added, enthusiastically.

Both Tom and Rick spent all day Thursday and part of Friday in preparing a joint paper on their repetition of Franklin's experiment. This paper was read at the regular meeting of the Jolly Philosophers called for the following Friday. The members were greatly elated when they heard of the wonderful success of their President and Chemist in drawing electricity from the clouds, and carefully and critically examined the kite with its projecting wire and silk covering. Even the string for raising the kite came in for its share of examination. They were proud they belonged to a Society that had in its membership two boys who could do such great things.

After the reading of the paper a long and interesting discussion took place concerning lightning strokes. This discussion showed that all had been reading extensively on the subject of lightning.

On the completion of the discussion Tom did not fail to call the attention of the boys to the statement made by Mr. Alexander as to the serious dangers of experiments of this kind, and frankly told the Society that he had agreed with Mr. Alexander that he would never again repeat such an experiment without advice from some grown person.

"You needn't be afraid, Tom," said one of the boys, laughing, "that any of us would attempt to make such experiments. We don't know enough about electricity to go monkeying around lightning flashes."

As it was now near the end of June, it was agreed that when the Society adjourned, it would adjourn to meet the first Friday in September, unless a special meeting was called before that time by order of the President.

After the usual half hour of fun was thoroughly enjoyed by the members, the Society adjourned for the summer.

On the following Saturday Tom's team had another match game in the Park with the same team that they played in the game referred to in the first chapter, and again won the game, the score in the 12th inning being 1 to 0.

When the game was over, Tom, Rick, Ralph, Abe and Sandy walked home together. The question arose as to how each intended to spend the coming National holiday, the Fourth of July. Fire-crackers and other explosives were suggested, when some of the boys asked Ralph if he expected to make his share of noise on the Fourth.

"No," replied Ralph, "I don't believe I care quite as much for such things now as I did a few years ago. I would much prefer a pleasant walk in the Park," and then, as the boys commenced to laugh at him, he continued: "Of course, I may fire off a few packs of fire-crackers, but I don't intend to make myself tired this year in making the neighbors tired of the racket I am kicking up. I say, boys, how would you like to change the usual Fourth of July programme, and, instead of employing the heathen Chinese method of celebration, spend the whole day in the Park; or, what is still better, hire a rowboat and spend the day on the Schuylkill. Of course, we'd take our lunch and make a day of it. There are plenty of fields on the banks of the Schuylkill where we can have a good game of ball, or even races, or athletic sports, when we get tired of the boat."

"I'll go with you, Ralph," replied Tom. "Your idea is all right. I vote for the rowboat rather than the walk. If we take a boat with two pairs of oars, four of us can row and the other boy can steer. I suggest we row up the river somewhere outside the Park limits, where we will be freer, and will not be stopped in any of our fun by the Park guards."

"Is there any good swimming up the river, Tom?" asked Ralph. "Of course," he added, "I mean if one wears tights. I suppose the only trouble would be to find some place to undress."

"If we go above Lafayette," replied Tom, "and take our swimming tights with us, we will have no trouble in getting a good swim."

"I'll gang wi ye, Tom," said Sandy; "I ken we'll hae a bonny time."

"Add I'll go too, Tob," exclaimed Abe. "I ab very fodd of swibbidg, add I do we'll have a good tibe."

"Then," said Rick, "I suppose I must go too. But if you expect me to give up all Fourth of July noise, you will find yourselves mistaken."

"Oh, as to that, Rick," said Tom, "I guess we will let a little boy like you have some fun. You may bring a few pulling crackers and baby torpedoes if you like."

"All right, Tom," said Rick laughing. "But don't be surprised if I bring something else."

That year the Fourth of July came on Wednesday. In order to make an early start it was agreed that Tom and Ralph should start early in the morning, hire a boat at the Fairmount boathouse a short distance above the dam, near the Green Street entrance, and bring it up the river to some convenient point near Strawberry Mansion. The other boys were to bring their lunch baskets, baseballs, bats, and other things to this point where they would wait for the boat, some of them agreeing to bring Tom and Ralph's things along with theirs.

All five boys had been so accustomed to rising on the Fourth of July at an outrageously early hour in order to properly celebrate the day with fire-crackers and other explosives, that they had no difficulty in getting up at an hour which permitted them to make the early start proposed. Indeed, Tom and Rick started after so early a breakfast that they reached the Fairmount boathouse long before the time they had intended. Here they hired a good-sized rowboat with two pairs of oars and a rudder for steering.

It was fortunate that they came early; for, happening to mention that they expected to go up the river as far as Lafayette, the man from whom they hired the boat said:

"Have you got your clearance for the canal locks?" and then, seeing that they did not understand, explained that to reach this part of the river they must pass through two canal locks, one at Manayunk, which would admit their boat to the canal at that place, and the other at Flat Rock Dam, that would "lock them out" to the river; *i.e.*, place them on the water above the dam.

"Where can we get these papers?" enquired the boys.

"At the canal locks opposite," said the man, pointing to the western side of the river, immediately above the dam at Fairmount.

It took them at least half an hour to get the clearance. After describing the character of their craft or boat, giving the name of their Captain, the number of their crew, and their destination, they got the papers, paying a certain sum of money for the "lockage;" *i.e.,* the toll levied for passage through the locks.

"You will give up these papers on your return," said the man, "when you pass through the lock at Manayunk."

By rowing rapidly they reached the point where they were to meet the other boys before their arrival. Shortly afterwards, however, the other boys, who were a little late, were seen approaching, laden with their lunch baskets, baseball, bats, mitts and gloves, etc.

"Hello," said Tom to Ralph, "what's Rick carrying?"

No wonder Tom was surprised, for Rick was staggering along with an immense grip. He was holding the grip as if he was anxious about its contents; for when Tom called to Abe and Sandy asking why they didn't help him with the heavy load, they shouted to them that Rick would not let them touch it.

"What have you in that grip, Rick?" asked Tom. "High explosives or what?"

"You would be surprised, Tom, if you knew," said Rick. "Keep your eyes open and at the proper time I will let you see. As long as none of you touch the bag it will be safe."

"All right, Rick," replied Tom. "We can trust you even if you are so small a chap."

It was a clear day, and, at that early hour, eight A.M., the air was pleasant and cool, although later it grew very hot. It was agreed that Rick should sit in the stern of the boat and steer. This pleased him, since it gave him a better opportunity to guard the big grip which he placed near him. They rowed leisurely up the river, keeping near the middle of the stream. Although early, there were many other rowboats on the river, the occupants of which, like themselves, evidently intended to pass the day on the water; for, they had their lunch baskets, cameras, etc., with them.

They were drawing near the railroad bridge not far from Chamounix, just as a long train of freight cars was crossing. From his position as steerer in the stern of the boat, Rick had a good view of the train, while the other boys, having their back towards it, could only hear it passing. The train was long and heavy, and the locomotive was using considerable steam. As the fireman had just thrown coal on the fire, dense clouds of steam mingled with black smoke came pouring out of the smokestack of the locomotive.

"Tom," said Rick, in an excited tone, "look at the mixture of smoke and steam escaping from that locomotive. What does it put in mind of?"

The boys stopped rowing for a moment and turned to look at the passing locomotive. Tom replied to Rick's question:

"Of the boiling and seething mass of the dark thunder clouds we saw in the western sky, on the afternoon of the great thunder storm in the Park, when the tree was shattered by the lightning stroke, and we got the lightning tube."

At the successive strokes of the engines on the two sides of the locomotive, columns of steam, mingled with smoke, were thrown with considerable force up into the air. After reaching a certain height they began to pour downwards, probably owing to friction, but the mass continued rising, because its temperature was higher than that of the surrounding air. In this manner, the mass had acquired a seething motion that made it resemble a boiling liquid.

Further up the river they passed a factory, from a smokestack on which they could see successive puffs of steam escaping apparently from a small stationary steam engine.

"Isn't that engine running fast?" exclaimed Tom.

"How do you do, Tob," enquired Abe. "You cad't see the steab engide, so how cad you say it is ruddidg fast?"

"Because, Abe," was the reply, "two puffs of steam escape into the air each time the fly-wheel of the engine makes one turn, that is, every time the piston moves once to-and-fro in the cylinder. If, therefore, you count the number of successive puffs, as we can here, it is easy to tell how fast it is running."

"That's so," remarked Abe. "It's so easy whed you wudz do that you wudder why you dever thought of it before."

While they were looking at the successive puffs of the steam, the engine slowed down and the puffs followed one another at much longer intervals. At last the steam following each puff escaped into the air in the form of a beautifully shaped ring, that increased rapidly in size as it rose. As Ralph remarked, it was not unlike the rings of smoke that are often seen when smokers blow the smoke out of their mouths in a certain manner.

"Have you ever made smoke rings, Ralph?" enquired Tom, winking at him.

"Yes," said Ralph, good-naturedly, "often. But not since the promise I made at the meeting of the Society when I was initiated."

"If you come to the laboratory sometime, Ralph," said Tom, "I will show you how to make smoke rings without burning tobacco."

They passed through the two locks, and as they went further up the stream, they came to the soapstone quarries, where a vein of soapstone passes under the river, as can be seen from quarries that had been opened on both the eastern and western banks.

XVIII.

AN OLD TIME FOURTH OF JULY WITH VARIATIONS

Towards noon the party landed on a small island on which no one lived, and on which the land had not been cultivated. They determined to wait here until lunch time.

"Rick," said Tom, "it's too early for lunch. Show us what you have in your grip. If it's what I think, you've got a regular Fourth of July treat for us. Am I making a good guess?"

"You hit it that time, Tom," replied Rick. "I guess I'll begin to unpack as we are in a good place for experiments."

Rick opened the grip and took from it several hot-air balloons and began inflating one of them by means of a sponge he dipped in coal oil and attached to a wire at the middle of the mouth of the balloon, igniting it with a match. When the balloon was nearly ready to rise, he attached a thin wire below the burning sponge. This wire held three large cannon crackers fixed to it, and was of such a length that the nearest cracker was at a distance of two or three feet from the flame. He then attached a piece of fuse to the crackers of such a length that the light would not reach the crackers until about half a minute after the balloon had begun to rise. When everything was ready he lighted the end of the fuse and set the balloon free. It rose rapidly in the air, and half a minute after leaving the ground the crackers exploded, much to the delight of the boys.

"That's jolly, Rick," said Ralph. "Not a bad way of firing off crackers. Send up one of these in the next balloon," he said, pulling out of one of his pockets several packs of fire-crackers.

Rick was very much tickled when Ralph produced the crackers, and began jollying him, saying:

"I thought a great big boy like you no longer enjoyed the heathen Chinese way of celebrating the Fourth of July?"

"You have it on me there, Rick," said Ralph, laughing, "but last night when I was buying some things for to-day, I saw a lot of fire-crackers, and couldn't resist bringing a few packs with me, being pretty sure that some of you would enjoy them, as indeed, I expect to do myself. How about you, Tom?" he continued, turning to Tom.

"Well I felt about the same way you did, Ralph," replied Tom, taking several packs of crackers from his pocket.

"And yet," said Rick, in a jollying tone, as the other boys shouted with mirth, "it is a heathen Chinese practice. Eh, Tom?"

There was another shout, when Abe and Sandy also pulled packs of crackers out of their pockets. It appeared, when talking the matter over afterwards, that although all except Rick had agreed that fire-crackers were too childish for boys of their age, yet when the time came they had loaded themselves up with fire-crackers as a matter of course, habits being so strong in boys, especially habits that have noise connected with them. Indeed, a racket on the Fourth of July might seem to be the birthright of a growing, healthy, American boy, and is not always lost with advancing years, but sometimes continues up as far as second childhood. The boys had, therefore, loaded themselves with fire-crackers.

THE PACKS EXPLODED AT DIFFERENT DISTANCES ABOVE THE EARTH

At the request of his companions Rick inflated a second balloon to which he attached several packs of crackers, and attached to them pieces of fuse so that the packs exploded at different distances above the surface of the earth.

"Rick," exclaimed Abe, "that is certaidly a bost spleddid way of firidg crackers."

"It is wonderfu," said Sandy. "I kenned we'd hae a gude time."

"Let's send up five packs of crackers in the next balloon," suggested Ralph. "I guess it won't hurt here in the country, will it Tom? but it might be dangerous in the crowded city."

"It certainly would be dangerous in the city," said Tom, "but I don't believe there will be any danger here, so far from any houses or buildings that might be set on fire."

"I have only one balloon left, Ralph," said Rick, "and I want to keep that for to-night, when we will send up a lot of red fire. It will show the red light splendidly, burning when the balloon is far up in the air."

The boys now began to set off their fire-crackers, and have a good old Fourth of July time generally. It was fortunate they were far outside the Park limits, since such racket would most certainly have been promptly stopped by the Park guards.

When the supply of crackers was nearly exhausted, Rick took out his penknife and commenced whittling a small piece of wood into the shape of a rude boat.

"What are you doing now, Rick?" exclaimed Ralph.

"Wait and see," was the reply.

As is well known to boys, when a fire-cracker has its charge of powder loosened by rolling it under one's foot, instead of exploding with a loud noise, when fired, it burns more slowly, the gases formed escaping in a nearly continuous stream. When such a cracker is placed on the ground and lighted, it will move in an irregular path in a direction opposite to that in which the gases are escaping, on the same principle as that which causes the jets of water escaping from a rotary lawn sprinkler to produce a rapid rotation of the jets.

As soon as Rick had roughly fashioned the piece of wood into a boat he selected a large cracker, and placing it under his foot, rolled it into a squib. Then attaching it firmly to the stern of the boat by a staple he had brought for the purpose he pointed the bow away from the shore and lighted the squib. To the great delight of the boys the boat was moved by the escaping gases rapidly over the water.

"That's a capital idea, Rick," said Tom.

All the boys now began making squib boats. Tom made a boat in which he placed four squibs, so arranged as to ignite one after the other. This new type of boat was a great success, except that, instead of moving straight out from the shore, it took on a different course each time a new squib ignited, so that when the last squib was fired the boat actually came back to where Tom was standing, just as a boomerang wielded by an expert thrower might have done.

"There," said Tom, "what do you think of that as an improvement, Rick? Make your boat come back to you for another trial."

"Capital, Tom," replied Rick, "but was not that accidental?"

"That's a true bill," said Tom, laughing.

Ralph made a form of squib boat, in which four squibs placed side by side were simultaneously ignited. On trial this resulted in a very rapidly moving boat.

A series of squib boat races now began in which they had no little fun. When they got tired of this work they turned to Rick and said:

"Well, old boy, what other tricks have you up your sleeve, or at least in that grip, for it seems that it is still well loaded."

Rick smiled as again turning to the grip he took out of it a small bottle containing a chemical substance known as calcium carbide. This chemical possesses the curious property, when thrown into water, of liberating acetylene gas, a substance that readily burns in the air with a bright light, and is, therefore, extensively employed for the purposes of artificial illumination.

As Rick took some of this substance from the bottle, Abe enquired:

"Have you sobethidg dew to show us, Rick?"

"That depends," said Rick, "on whether you have ever seen this before. Watch and see what happens when I throw some of it into the water in this tomato can."

With this Rick threw several pieces of calcium carbide, a dark looking substance, into the can of water. It was much heavier than the water and instantly sank to the bottom, when a bubbling and boiling immediately took place and a gas with a disagreeable odor came off. As soon as Rick touched this gas with a lighted match it at once burst into a flame.

"Aweel, aweel," cried Sandy in amazement, "that's a bonny light. I wudna ken you had done it so easy."

"Have you never seen calcium carbide before, Sandy?" enquired one of the boys.

"Speer me nae questions and I'll tell ye nae lees," replied Sandy, winking at Rick.

Rick's grip appeared indeed to be almost inexhaustible; for, again going to it, he took out a small empty tin can, from the top of which a small circular piece of tin only had been removed. Holding it for a moment with the mouth downwards he cautiously applied a match to near the opening at the bottom. There was instantly a loud explosion, and a momentary column of flame burst out from the other end of the can. The noise was much louder than any of the large crackers they had shot off, and greatly surprised the boys.

"That's a new one for me, Rick," said Ralph. "I have read that a mixture of acetylene gas and air is explosive, but I have never seen the experiment tried before."

"Try it agaid, Rick," said Abe. "This is bore like a real Fourth of July. That bakes albost as loud a doise as a sball caddod."

This last experiment of Rick's tickled the boys more than anything he had shown them. At their repeated requests he made and successfully exploded a number of mixtures of the gas and air. Some of these produced explosions much louder than others, this being due as Rick explained to the fact that a mixture containing certain proportions of air and acetylene gas is more explosive than others.

Rick told the boys that in performing this experiment care must be taken that the vessel containing the mixture of gas and air should be provided with a fairly wide opening, since unless the heated gases could readily escape from the can, there might be a serious explosion. It was also necessary to avoid placing one's hand in the path of the flame accompanying the explosion so as to escape being burned.

The boys had been so much interested in Rick's experiment that they had actually forgotten their lunch. At last Tom said:

"Let's leave the island, row over to one of the banks of the river, climb a hill, and eat our lunch near the top, where we can have a view both of the river and of our boat."

Tom's proposition was agreed to. A suitable place was soon found where the boys attacked their lunch with an appetite common to healthy, growing boys, and frequently greatly envied by their elders. After lunch, they lay on the grass for awhile in the shade of a big tree, talking about various things. This conversation was characterised by the chaffing so common among lively boys. While doing this, one of the boys, who had been lying on his back looking up at the sky, suddenly jumped up and said:

"Here comes the big balloon that was to start from the Point Breeze gas works to-day."

As the balloon slowly passed overhead, they could distinctly see its basket suspended by a network of cords passing over the top. Tom had brought with him a pair of powerful opera glasses, so he could easily count the number of people in the basket. After looking for a few minutes, he passed the glasses to the other boys, so that they could look.

Later in the afternoon they had lots of fun with their baseball and bats. They also had quite a number of foot races and jumping races.

Towards four o'clock in the afternoon, Rick said:

"How about that swim? A good swim just now would be about the right thing."

Rick's proposition met with instant approval by all the boys, so going down to their boat they began pulling down the river towards Lafayette.

"Do you know of any good place for a swim, Tom?" asked one of the boys.

"Yes," replied Tom, "there is a good swimming place a short distance below here, where the Philadelphia Swimming Club, formerly the National Swimming Association, has built a small clubhouse. If we can find a place where we can undress and put on our tights, we can get a splendid swim."

As they were rowing down the river, Rick saw following them down the stream, a short distance beyond, a boat containing four men: Each man was pulling an oar, but the boat was very badly managed, for instead of continuing in a straight course, it took a zig-zag route that spoke very little for the skill of the rowers.

"I call that pretty poor rowing," said Rick.

As the boys turned to look at the boat which Rick spoke about, Ralph exclaimed:

"The men are drunk, Rick; look out they don't bump us."

As the boys turned around to resume rowing, they saw a racing shell containing a single man who was rowing in great form up the river.

"Now there's rowing for you," said Tom, looking critically at the man; "see what a splendid stroke he has, and how magnificently he is built. That man has not much to learn about rowing."

At this moment the rower in the single shell turned around to see if any boats were in his way. Since the boys' boat was in the middle of the river where it would not come in contact with him, and since at this moment the boat containing the four men had taken a sudden turn, and was apparently making straight for the right hand bank of the river, it did not appear that there was any danger of a collision. The man, therefore, turned around and apparently concluded to make a spurt, for he rowed the boat at a speed which caused it to appear to fairly fly through the water.

As the boys' boat drew near the boatload of drunken men, the latter's boat suddenly turned in a direction that would bring it directly against the middle of the racing shell unless the shell changed its direction.

Tom now shouted to the drunken men as well as to the man in the shell to look out. The men in the first boat, however, were either too drunk to understand what was said to them, or, apparently thinking the boys were challenging them to a race, began pulling with drunken frenzy. By chance, this urged their boat forward in a direction that threatened to make it strike the single shell near the middle. As soon as he heard the warning, the rower in the shell had turned, and seeing the danger, dexterously headed his boat towards the shore. While too late to avoid a collision, he succeeded in so changing his course that the rowboat struck against his stern, carrying away a part of it and throwing the rower in the river.

Though dazed by the shock and immersion, the man succeeded in catching hold of his boat, but was apparently unable to make any further efforts towards saving himself.

The accident had occurred when the boys were near the colliding boats. Quickly rowing in the direction of the injured scull, they reached and lifted the man in their boat, and then catching the overturned boat, commenced towing it towards the nearer shore. The drunken men, however, continued their course, either unaware or unmindful of the damage they had caused.

The gentleman, who was only slightly dazed, almost immediately recovered his consciousness, and said:

"Much obliged, boys; is my shell much injured? Where are those drunken fellows who ran into me?"

"Your shell is injured near the stern," said Ralph. "The injury, while not very bad, will prevent your using it again to-day. As for those fellows they have gone on down the river, apparently too drunk to know what they have done."

By this time they had reached the bank of the river, where the gentleman began to examine his injured shell.

"If not too much trouble, boys, I would like you to take me and my shell to the house of the Philadelphia Swimming Club, where I was just going for a swim. It is only a short distance below here. I wouldn't bother you, but I must leave my boat in some safe place until I can get it repaired. If I get it to the clubhouse, I can have it taken care of."

After ten minutes hard pulling the boys succeeded in reaching the clubhouse, when obtaining help from some of the men he had the shell placed in a safe place.

Then going to a telephone he sent a message to the lock at Flat Rock Dam, asking the lockman to look out for a boat with four men, as he intended to bring suit against them for damages to his boat.

It may be said in this connection that the men were stopped while passing through the lock and their addresses ascertained. Being fairly decent men when sober, they afterwards willingly paid the expenses of repairing the boat.

"Where were you going, boys?" enquired the gentleman, "when you came to my help?"

"We were looking for a place where we could have a swim. We have our tights with us, but we have not as yet found any place where we can undress."

THE BOYS WERE SOON ALL IN THE WATER, ENJOYING A SPLENDID SWIM

"I am a member of this club," said the gentleman. "Come into the clubhouse and undress, and we will have a good swim together."

Glad to accept the invitation, the boys were soon all in the water enjoying a splendid swim.

The gentleman introduced himself to them as Gideon Gordon, adding that he was connected with the Western Union Telegraph Company. He was an accomplished swimmer and held the championship medal for long distance swimming. He showed the boys several new strokes in swimming, especially the new crawl stroke, the fastest known stroke, and to their great delight, invited them to come occasionally to the clubhouse as his guest, and learn more about swimming.

When the swim was over the boys offered to take Mr. Gordon to the city. He excused himself, however, as he wished to see about getting his boat repaired as soon as possible.

On their way home the boys saw an exhibition of fireworks, and succeeded afterwards in raising the hot-air balloon, to which they attached a large pasteboard tube filled with red fire, which was ignited by a fuse when the balloon reached a hundred feet above the surface of the earth. The fire continued burning for at least five minutes, exciting much admiration from the people who saw it.

The boys reached home safely late at night. They agreed that this was the jolliest Fourth of July that they had ever experienced.

XIX.

MR. ALEXANDER AND MR. DODGE VISIT TOM'S LABORATORY

On Monday, July 9th, the day Messrs. Alexander and Dodge had promised to visit his laboratory, Tom and Rick went there shortly after dinner. As it was only half past one, and they did not expect their visitors until four, Tom suggested that they should file and polish two straight bars of steel, so that when they made their next visit to the electric lighting station they could get Mr. Alexander to magnetize them by the Edison machine he had employed for magnetizing their penknives.

"I have some good tool steel here," said Tom, taking a bar of steel from a rack placed against the wall. "Let's saw off two equal lengths and file them true."

So they cut off two pieces of steel about four inches in length, and spent some time in filing and truing them off, and then polishing their surfaces. The tool steel was fairly soft and cut easily.

"When completed we must have the bars hardened by heating them red hot, and immersing them in a cold liquid."

"What do you want to harden them for, Tom?"

"Because soft steel, though easily magnetized, easily loses its magnetism," answered Tom. "Don't you remember," he continued, "what Mr. Alexander said when he magnetized our penknives? 'If your knife blades are made of good hard steel they will never forget that I have magnetized them; but if they are made of soft iron, or soft steel, they will almost instantly lose their magnetism.'"

While they were working at the steel bars, Ralph came into the laboratory, for Tom had invited him to come and meet the gentlemen. When Ralph learned what they were doing, he said:

"Tom, if you can spare me a piece of steel, I would like to cut it into shape and get Mr. Alexander to magnetize it when you take your bars to the station."

"Certainly, Ralph," replied Tom. "Here is the bar from which I cut our pieces. Put it in the vise, so as to hold it while you saw a piece off with this metal saw," handing the saw to Ralph as he spoke.

The boys concluded to make the three bars magnets of exactly the same length. They were in no hurry, and, therefore, had time to make a good job. It also took them some time to give a good finish to the bars, so that they had not more than completed this when Mr. Alexander and Mr. Dodge came into the room.

"Good afternoon, boys," said Mr. Alexander, "you see we have kept our word."

"Yes," replied Tom, "and we are very glad to see you."

"Why, Tom," said Mr. Alexander, as he looked around the room; "this is a splendid place for working. What have you been doing?" he added, examining the bars of steel. "Going to make magnets?" he enquired.

"Yes, sir," replied Tom, "as soon as the bars are hardened, we intend taking them around to your lighting station and getting you, when you can find the time, to place them against the machine, just as you did for our penknives."

"All right," replied Mr. Alexander; "bring all three along, and bring Ralph, if he would like to come. But before you harden the bars there is one thing you ought to do that I see you have not done. Make a small indentation with a punch, exactly in the middle of each bar, so that when placed on a vertical needle point the bar will come to rest in a horizontal position. You can then use the magnets as magnetic needles. Before you harden the bars, be sure to see that the indentations are exactly in the middle, so that one end will not be heavier than the other. If a bar doesn't balance, it will be necessary to file off a small part from the heavier end.

"And now," he continued, "show us the lightning tube, and the photographs of the lightning flashes, you told us about the other day in the Park."

Both gentlemen were much interested in the photographs of the lightning flashes, as well as the lightning tube which they carefully examined. Mr. Dodge was especially interested in the lightning tube. After examining it for a long time he said to his companion:

"Alexander, it must have been a powerful discharge that produced this. See how much sandy earth it has melted and converted into glass." Then turning to Tom he said: "I am especially interested in this specimen because I am preparing a scientific paper on some of the effects of powerful electric discharges. I would like to ask you questions concerning the flash that produced it."

"Rick and I will tell you all we can about it," replied Tom; "for we both saw the lightning flash that formed the tube and both worked together in taking it out of the ground."

Mr. Dodge then asked the boys a number of questions and was much pleased, and no little surprised at the intelligent answers they made, showing that they were close observers of natural phenomena.

"If you don't object," he said to the boys, "I should like to borrow this specimen, so as to have a photograph taken of it, and also to have a good artist prepare a cut for my paper."

The boys were much pleased at the interest Mr. Dodge took in their lightning tube, and promised to leave it at the power station the next day.

When Mr. Alaxeander examined the photographs of the multiple lightning flash, he said:

"This is a capital photograph of a very rare form of lightning flash. Let me see your camera, and the way you exposed it on the night of the storm."

After carefully examining both the camera and the position it occupied during the exposure of the plate Mr. Alexander turned to Tom and said:

"Now, let me see the negative from which the photograph was printed."

They went into the dark-room with Tom and after carefully examining the negative, Mr. Alexander said:

"You are a good photographer, Tom. This negative is focussed well, well exposed, well developed, well fixed, and well washed. Where did you learn photography?"

"I have a friend," replied Tom, "who is a practical photographer and who showed me how to work. He lets me go into his dark-room and see him working. I think one loses a great deal of fun in photography by letting other people develop, fix, and print the pictures."

"You are right there," said Mr. Alexander, looking at Mr. Dodge and smiling. "Now show me some of your electrical apparatus. I mean some of the things you have built in your laboratory."

"Show him some of the tricks that you did at the Society meeting," said Rick.

"Yes," said Ralph, "and show him your thief-detector."

"What's this I hear;" said Mr. Alexander, again looking at Mr. Dodge and laughing. "To begin with, what do you mean when you talk of the Society?"

"It is the name of a Secret Society called the Jolly Philosophers," said Tom.

"Excuse me, Tom," said Ralph, laughing. "You are not giving our Society its full name. You should call it the Ancient and Honorable Society of the Jolly Philosophers."

"That's right," said Mr. Alexander, "I want the full name of the Society. Now please tell me what are the objects of The Ancient and Honorable Society of the Jolly Philosophers?"

Tom explained in full the nature of the Society, its membership, together with a brief description of some of its work.

"That's a splendid idea, Tom," he exclaimed. "Dodge, you and I must attend some meeting of this Society during the coming fall or winter. Can we come, boys," he enquired, "or do you only admit members?"

"There are exceptions to every rule," replied Tom laughing. "I am sure all the boys would be glad to have both of you pay us a visit."

"Now tell us something about the scientific tricks you play on the boys, Tom," said Mr. Dodge. "I should like to hear something about them, especially about the thief-detector."

Tom explained the tricks he had devised with the Leyden-jar batteries, such as the book containing the by-laws of the Society, the photograph of the baseball team and the removable colors, the electrified goblets, etc., but what especially tickled the gentlemen was the clever manner in which Tom had punished the intruders in his laboratory by knocking them senseless when they tried to handle things they had no business to touch. In telling this last story, Tom was careful not to mention the name of A. Phineas Skinner, since both he and Rick had agreed to keep the boy's name a secret and give him a chance to reform.

"I see," said Mr. Alexander, after Tom had told him about the trick, "that you have been reading about some of the experiments tried so many years ago in Philadelphia by Ben Franklin. Tom," he continued, "these things show me that you understand electrical matters much better than I had thought. Nevertheless, I don't take back what I said about the danger of trying experiments with lightning flashes."

"I won't forget my promise, Mr. Alexander," replied Tom. "I shall not try such dangerous experiments without first talking with you or some other older person than myself about them."

The visitors spent at least an hour in the laboratory. As he was about to leave, Mr. Dodge said:

"Don't forget you have promised to leave the lightning tube to-morrow at my power station. I cannot show you the station to-morrow as I will be busy all day, but call me up on the phone any day a week or so from now, and I will try to arrange showing the station both to you and to your friends," he said, looking at Rick and Ralph.

After the gentlemen left the laboratory and were out of hearing Mr. Alexander said:

"Dodge, those are brainy boys, especially Tom."

"They are, Alexander," said Mr. Dodge. "There is the making of a great electrician in Tom. We must do what we can to encourage and help him in his studies."

"Yes," replied Alexander. "I am much indebted to him and intend to become better acquainted."

The boys began talking about their visitors as soon as they were alone. From the nature of their conversation it was evident that the gentlemen had made a very favorable impression on the boys. It is so true that a little properly given encouragement greatly aids the young in their work, that, perhaps, without knowing it, these men had already done what Mr. Dodge declared he intended to do; *i.e.,* to encourage and help the boys in their studies.

The boys now proceeded to make punch marks in the centres of the bars for suspending them on needle points. Although they tried to make these indentations as nearly at the centre as possible, yet they found the bars did not balance, so that it was necessary to file away a portion of the heavier end before the bars remained in a true horizontal position when at rest. This, however, was at last accomplished, when the boys were ready to have the bars hardened.

"We can't do this ourselves," said Tom, "let's go to the nearest blacksmith, and get him to do it for us. I don't believe he will charge much for the work."

They were soon in a blacksmith shop a few blocks from where they lived. The blacksmith, John Hogan, was no little surprised at the age of his customers, but was a good-natured man, and as soon as he understood what the boys wanted he said:

"Certainly, boys, I will do it for you," and taking the bars he placed them in his forge covering them with the glowing coals. "How hard do you want them?" he enquired of Tom. "I see you have used good steel, so that I can get almost any hardness you want."

"Make them as hard as you can," said Tom. "We are going to have them magnetized, so the harder you make them the longer they will keep their magnetism."

The blacksmith at once became interested in the matter of magnetism, and asked Tom many questions while he was heating the bars.

"I don't know much about such things," he said, "but I want to learn." And so he continued asking questions, to which Tom replied in his usual clear manner.

As soon as the bars were uniformly heated the blacksmith took them one by one from the fire with a pair of tongs, dropped them in a bath of cold oil, from which he removed them in a few minutes. They not only came out of the bath straight and true, but so hard that they readily scratched glass when rubbed against it.

"There," he said, handing them to the boys, "they are not only hardened, but, as you see, have not warped in cooling. Had you tried to do this work yourselves the chances are that the bars would have become very crooked, since, not having a forge, and not having been accustomed to this work, you would probably have heated them more at one place than at another."

When Tom asked the blacksmith what his charge was, he laughed and said:

"You don't owe me anything, my lad. I think I have got more out of you in the way of information about magnetism, than you have out of me in the way of work. If you have any more of that kind of steel and will bring me three bars, I will forge them into the shape of horseshoes, so as to bring the ends of the bars near together. This, I understand, is the shape usually given to magnets."

"That will be splendid," said Tom, "but it is hardly fair to ask you to do so much for us for nothing."

"If that bothers you," said Mr. Hogan, good naturedly, "I may ask you to get a bar and a horseshoe magnetized for me, as I want to learn more about magnetism."

"All right," said Tom, "it's a bargain."

The boys left the blacksmith, and Tom said to the boys:

"Meet me at the laboratory to-morrow morning. We will cut and shape three bars of steel and then get the blacksmith to forge them into horseshoes, and afterwards harden them."

"Tom," enquired Ralph, "what's the matter with making two extra bars so that the blacksmith can keep a straight bar and a horseshoe bar? I remember that there was not much left on your bar of steel, so we will all chip in and buy another bar."

"That's a good idea, Ralph," replied Tom. "We'll follow it."

XX.

SOME ADDITIONAL EXPERIMENTS IN MAGNETISM

The next day, after finishing the bars, they took them to the blacksmith, who was much pleased with the two extra bars the boys had brought him. He was busy at the time, so they had to wait until he finished the job he was at. After heating the bars he skilfully forged them into the horseshoe shape, leaving, however, one of them straight. He then hardened them.

Taking the bars with them the boys went that afternoon to the power station, which, as will be remembered, was at a considerable distance from where they lived. They were fortunate in finding Mr. Alexander both in and disengaged, so that he was able to show them the station. He then said:

"Well, boys, I suppose you have brought the bars of steel. Let me have them and I will magnetize them for you."

"We have brought them, Mr. Alexander," said Tom, "as well as some horseshoe bars."

"Hello," said Mr. Alexander, looking at the manner in which the horseshoe bars had been wrought. "Who did this work? I am sure you did not, Tom, for it is unusually good work. I expected the other day, when you told me that you would harden the bars by heating, that you would get them warped and crooked, for it is not an easy thing to do this kind of work."

Tom now explained what the blacksmith had done for them and why they had brought four straight bars and four bent bars with them to be magnetized.

The many separate pieces of steel they had brought with them, appeared to require so much work by Mr. Alexander in magnetizing them that Tom said:

"I am afraid, Mr. Alexander, that it will take too long for you to magnetize all these."

"It will not take me long to magnetize the straight bars, Tom," he replied, "but the U-shaped bars are different. However, if you leave them here I will get them magnetized for you."

Mr. Alexander had magnetized all the straight bars in less than a minute, since in order to do this he merely placed them against a part of the Edison machine.

They left the U-shaped bars with Mr. Alexander and were about going home, when that gentleman said:

"Tom, how would you and your friends like to spend a half hour with Michael O'Toole in the boiler room? As we passed through the room a little while ago, Michael asked me to let you come back and make him a short visit."

"I am very sure we would all like to do so very much," replied Tom.

"Very well then," said Mr. Alexander, pointing to the circular stair-case down which they had come, "you know the way. Stop in a few moments on your way out and see me."

When the boys entered the boiler room, Michael O'Toole greeted them in a pleased tone.

"The top of the day to yez, Misther Brown, and Misther Justice. Plaze make me known to the other young gintleman," pointing to Ralph.

Ralph, like Tom and Rick, at once became very much interested when Michael explained the method employed for feeding the furnaces with coal, the different devices on the boilers for indicating the steam pressure, height of

HE HAD SLIPPED A HOLLOW COIL OF INSULATED WIRE AROUND THE MIDDLE OF ONE OF THE U-SHAPED BARS

water, etc., as well as the means for forcing the water into the boilers against the pressure of the steam they contained. Indeed, Ralph appeared to understand the explanation even better than Tom or Rick had, and asked so many intelligent questions that the Irishman was in raptures over him.

"It's indade a pleasure," he remarked, "to talk to such broight byes. It makes me think that ye must have come from the ould country."

"You are right there, Michael," replied Ralph. "I understand that my great-great-grandfather came from Ireland, and am told that he regarded that country as a very wonderful place."

"In faith, he knew what he was talking about," said the pleased Irishman. "I no longer wonder that ye are so broight."

As the boys were leaving the building, they called as requested on Mr. Alexander, who said:

"Wait a moment, boys," and going to a speaking tube he said to some one at the other end of the tube:

"Is that coil ready yet?"

The answer was evidently satisfactory for he said to the boys:

"Come with me and I will show you how to magnetize a U-shaped bar by passing a current of electricity through an insulated coil of wire wound around its centre."

Taking the boys into the generating room, they found that workmen had slipped a hollow coil of insulated wire around the middle of one of the U-shaped bars, and had so connected the ends of the coil with an electric circuit, that the movement of a switch caused a strong current of electricity to flow through the coil of wire. After permitting the current to flow for half a minute, the switch was opened, thus causing the current to cease flowing, and the

U-shaped bar removed. The other U-shaped bars were then successively placed on the coil in a similar manner so that they were all successfully magnetized. The entire process did not take more than five minutes.

Mr. Alexander advised them to place a straight bar of soft iron across the ends of the magnets when not in use.

"Such bar," he said, "is called an armature. Its use will prevent the magnet from losing its magnetism."

The next time they met in the laboratory they naturally began to make experiments with their magnets.

"I understand," said Tom, "that it is easy to spoil a magnet by accidentally touching it with another magnet, since, the bar becomes magnetized at the point touched. Now let's be careful not to permit our magnets to touch one another."

"Tom," said Ralph, "I know very little about magnetism. Won't you please tell me something about this strange force?"

"Yes, tell us, Tom," said Rick.

"I don't know as much about magnetism as you seem to think, Ralph, though I have read much about it; ask any questions you wish. If I can answer them I will, if I can't, we'll read some books on magnetism, and try to find the answers ourselves. If we can't do it, then we will talk the matter over with Mr. Alexander and Mr. Dodge, and get them to help us over the hard places."

"It's lucky we met those gentlemen," said Rick. "I hear that Mr. Askinson has left Philadelphia for the holidays and does not expect to return until the opening of school next September."

"Let me have your first question," said Tom.

"How can you tell which pole of a magnet is north and which is south, Tom?" asked Ralph.

"Let me first show you something," said Tom.

Taking the three bar magnets, Tom placed them on separate vertical needle points supported at the top of a vertical rod of brass inserted in a heavy piece of lead. The supports were placed at such distances apart that the bars could not touch one another, as they swung around on their supports. Left to themselves the bars after swinging to and fro a few moments soon came to rest pointing nearly to the true north.

Ralph, who had been closely watching the bars, now exclaimed:

"Now I understand. Those are the north poles that point to the north. Am I not right?"

"Yes and no," replied Tom.

"Please read me that riddle," said Ralph.

"It is the opposite poles of magnets that point towards each other," replied Tom. "As I understand it the earth is a huge magnet with its magnetic poles near the ends of its axis. If, therefore, the pole of the magnet that points towards the north pole of the earth is a north magnetic pole, then the magnetic pole of the earth to which it points must be a south magnetic pole, while if we call the magnetic end of the earth in the Northern Hemisphere, north, then the end of the needle which points towards the north must be south."

"Goodness," said Ralph, laughing, "that's a pretty bad mixup. Has this trouble been straightened out?"

"I believe it has been settled by calling the north pole of a needle the pole that points approximately to the northern part of the earth. Sometimes," continued Tom, "in order to avoid this difficulty, the end of the needle which points nearly to the north of the earth is called the north-seeking pole, and the opposite end the south-seeking pole."

"Tom," said Rick, who had been listening carefully to the conversation, "is there any way of actually telling the north from the south magnetic pole?"

"I'm not sure that I can answer your question, Rick," said Tom, "but please ask it again when I have shown you some experiments with magnets."

"I won't forget," said Rick.

"Now," said Tom, "let's take one of our bar magnets and roll it in a mass of filings in order to see whether it possesses an equal power of attracting iron to it at all points on its surface.

Brushing off a part of the top of his carpenter's bench, Tom emptied a bottle of iron filings on it, and rolling a bar magnet in the filings, showed that they were attracted mainly to the ends of the bar; for, when the bar was removed from the filings, and tapped several times with the end of a lead pencil, the greatest amount of filings remained on the ends, while the middle of the bar contained none at all.

"How strange!" said Rick; "are our bars like this?"

"Try and see," suggested Tom.

Rick and Ralph now rolled their bar magnets over the iron filings, and, treating them as Tom had done, found that the filings had collected in exactly the same manner, the greatest amount at the ends of the bars with practically none in the middle.

Tom now pointed out to the boys the fact that one-half of each of the bars was oppositely magnetized, one-half exhibiting north polarity, and the other half south polarity; for, whenever a north-seeking pole of one of the magnets was brought near that half of a suspended magnet, that was nearer to the north, it was repelled, and when brought near the other half, it was attracted.

"How strange," cried Rick. "I wonder if the bar was suddenly cut in half we could get a magnet which possesses only north or south polarity."

"No," replied Tom, "all magnets must possess both north and south polarity. But let's try the experiment you suggest, Rick. It is easily done." Going to a drawer he brought out the main spring of an old watch. It was formed of good hard steel. Cutting off a piece about two inches long with a pair of metal shears, he magnetized it by touching one end of it to the end of a bar magnet, and its other end to the opposite end of the bar.

"Now," he said, "let's see how it will act on iron filings."

On rolling the magnetized piece of steel spring in the filings they were found to collect at the ends only, none whatever remaining in the middle. Tom now took a pair of metal shears and cut the small bar of steel in two equal parts. Placing these parts in the iron filings the filings were found to collect at both ends of the small bars with none whatever in the middle.

"Cut these pieces in halves again, Tom," requested Rick.

This was done; but the steel still showed the same distribution of magnetism, for when rolled in the iron filings, they still collected at the ends with none in the middle.

"Now, Rick," said Tom, "I am nearly ready to answer that question of yours, but first look at this experiment." He then took a clean sheet of glass and placing one of the bar magnets on the table, laid the glass over the magnet, and then sifted some fine iron filings through a piece of wire gauze, so as to spread them evenly over the plate. Then taking a lead pencil he tapped the plate gently, when instantly the filings collected in more or less continuous linear groupings surrounding the bar. These lines came together between the ends of the bar, but diverged from one another at the ends.

"Now, Rick," said Tom, "this grouping of filings form what is sometimes called a magnetic figure. The lines consist of what are known as magnetic streamings, or magnetic flux, or magnetism. The magnetism is assumed to come out of one pole or end of a magnet and after passing out through the space around the magnet, to reënter the magnet again at the other pole or end. These magnetic streamings extend to great distances beyond the magnet so that we can only see some of them on this glass plate. No one knows in what direction they are moving, since magnetic flux is invisible.

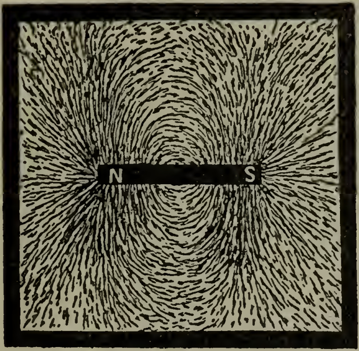
"Magnetism passes more readily through soft iron than through air. As soon, therefore, as the particles of iron fall on the plate the magnetic flux threads or passes through them. When I tapped the plate with the pencil, the magnetized particles of iron immediately arranged themselves, so as to permit the flux to pass through them like beads strung on a thread. Now, it has been agreed to call that end of a magnet out from which the flux passes its north pole, and the end into which the flux passes its south pole."

"Thank you, Tom," said Rick. "I understand now how you will answer my question. Since, in order for a body to be magnetized, it must have magnetic flux passed through it, the flux must enter in at one end and leave it at the other end. No matter, therefore, how small it may be, it must have two poles, a north pole, where the flux leaves it, and a south pole, where it enters it."

"Capital, Rick," said Tom, "that's just what I was going to tell you."

"Tom," said Rick, who had opened a book at a page on which was printed the magnetic figure of a charged bar magnet. "Here is a figure which closely resembles the figure we have on the glass plate."

"Yes," replied Tom, as he and Ralph closely examined the drawing and compared it with the arrangement of filings on the glass plate.



Magnetic Field of a Bar Magnet. Note the manner in which the iron filings are grouped around the bar; diverging from the north and south pole (N. and S.), and coming together between these poles.

"Tom," said Ralph, who had been listening carefully to Tom's explanation, "each of these particles of iron are little magnets, and cling together in lines by reason of the attraction of their opposite ends. Tom," he continued, "I wonder if we could not fix or fasten these iron filings to the glass plate so as to show the plate to the Society at its first meeting in the fall?"

"Let's try," said Tom.

They carefully heated a glass plate, and then covered one surface with a thin layer of wax, and set it on edge while still hot, so that the greater part of the wax drained off the plate. They then let it cool, so that, as the wax hardened, the plate was left covered with a thin layer of wax. Placing it now with its wax-coated surface upwards over a bar magnet and sprinkling a layer of fine iron filings through gauze wire over its surface, they tapped it gently, thus securing a magnetic figure. This was afterwards fixed by heating the plate, when the filings, sinking into the softened wax, became firmly attached to the surface of the plate, as the wax hardened. They then used this plate as a negative by placing it in the sunlight over a piece of blue print paper. A few minutes exposure enabled them to obtain a negative picture, since the portions uncovered by the iron filings printed blue while wherever the filings had collected the paper remained white, being unaffected.

"Boys," said Tom, "I think I can improve this method. Come into the dark-room and I will show you my plan." Taking one of the bar magnets and some iron filings with the sheet of gauze they went into the dark-room and closing the door, Tom took an unexposed dry plate and laid it with its sensitive side upwards on top of the bar magnet which he had placed on the table. He then sprinkled some iron filings over its sensitized surface and tapping it obtained a beautiful grouping of iron filings.

Lighting a match Tom held it for a second above the surface of the plate.

"Now," he said, "the trick is done."

"Splendid," said Rick and Ralph at the same time, for they at once understood the great simplicity of the method, which produced an accurate photographic negative of the collection of filings. All the unexposed parts of the plate were affected by the light, while the parts covered by the filings were unaffected. When, therefore, Tom afterwards carefully washed all the filings from the plate, and developed, fixed and dried it, he was able, by employing this photographic negative, to obtain beautiful positives with both silver paper and blue paper.

Tom afterwards found that he was not the first inventor of this process; that it had already been done by another. He had, however, as is often the case, truly invented a new process, since he had never seen a description of it when the idea first suggested itself to him.

As will be seen from the preceding, Tom had already acquired considerable knowledge from his reading concerning many of the leading facts in magnetism. The boys were so pleased at taking photographs of the magnetic flux that they spent several days in obtaining pictures, from one or several bar magnets, differently placed as regards each other, as well as from the horseshoe magnets.

XXI.

THE ARABIAN NIGHTS' ENTERTAINMENTS

There is so much that is mysterious about the force of magnetism that it has at all times strongly claimed the attention of mankind. It sems so strange that a body endowed with this invisible force is able to reach across space and attract or repel similarly endowed bodies. It was natural, therefore, that Tom, Rick and Ralph became greatly interested in magnetism and began reading what books they could get on the subject. Unfortunately, Ralph and his people soon left the city for the summer, so that he was unable to continue this study.

Tom and Rick were now left alone. Practically all their boy friends were either away on their vacations, or had obtained work for the summer. The two boys, therefore, spent, if possible, more of their time together than formerly, either in the laboratory or in rambling through the Park. One evening, in the early part of July, as they were leaving the laboratory, Tom said:

"Rick, let's take to-morrow off, and spend the whole day in the Park. We'll take our lunch, a baseball, bat, mitt and gloves, as well as something to read. When it gets too hot to walk or to play with the ball, we'll lie under a shady tree near the top of one of the high hills overlooking the river and read and chat."

"Agreed," replied Rick; "I'd like to suggest a change."

"Let's hear it," said Tom.

"That the reading matter we bring shall not be directly connected with either magnetism or electricity."

"Why, what's the matter, Rick," cried Tom, in amazement, "are you tired of study?"

"Not exactly," was the reply, "but I think a little change won't hurt either of us."

"I guess you're right, Rick. We'll do as you suggest."

Next morning, after an early breakfast, the two boys started for the Park, again crossing the trolley bridge at Strawberry Mansion. On reaching the opposite bank of the river they struck over the hills towards the Speedway, but this time instead of following it towards the northeast they walked towards the southwest. Although still early, the day was hot and sultry. When they reached the end of the Speedway, they turned to the left, followed the carriage road, and walked around to the front of the Restaurant or Mansion on Belmont Hill. Then continuing down the carriage road, they reached the athletic field, situated between the foot of the hill and Horticultural Hall.

The Belmont Athletic Field is another of the three great fields the Commissioners of Fairmount Park have set aside for the use of the boys and the men of the city. It has been levelled, re-sodded and rolled, and is in excellent condition, being laid out in a number of baseball diamonds. In the summer it is used mainly for baseball and in fall for football.

Only one of the diamonds was in use, and that not by a full team, but by some boys who were apparently holding it for the rest of their team.

The two boys stopped at the field and began playing with their ball, Tom batting the ball, and Rick going out into the field and endeavoring to catch and then throwing it to Tom who again batted it towards him. It was agreed that as soon as Rick caught three balls he should take the bat, so that in a short time Rick was batting and Tom was catching. They continued this for about three-quarters of an hour, when Tom said to Rick:

"Let's practice catching."

Going to one of the unused diamonds, Tom stood at the home plate, and Rick, taking the ball to the pitcher's box, delivered various kinds of balls to Tom, who caught them in the mitt he had put on while he was walking towards the home plate.

After a quarter of an hour's practice with the ball the air grew so hot that Rick, turning to Tom, said:

"Let's climb Belmont Hill and lie under one of the trees in the grove near the top, and read our books."

"All right," was the reply, "it is certainly getting too hot to play ball."

There are two small groves at the base of the Belmont Hill between the athletic field and the top of the hill, while near the top of the hill, not far from the flagpole, is another grove.

The boys climbed the hill to the grove near the flagpole, and laid down on the ground under one of the trees at the edge of the grove nearest to the athletic field. The air was unusually free from dust or haze so that they had a splendid view of some of the built up parts of the city of Philadelphia. Towards the southeast they could see the Schuylkill River spanned by two fine bridges that appeared from that point so near together that they almost looked as one bridge only. Far beyond, on the top of the tower of the Public Buildings, the statue of William Penn, although several miles distant, was clearly visible. Across the river was a part of the plateau near Strawberry Mansion, on which the Edgley ball field is located. The eastern edges of this plateau descend precipitately to the river.

There was a mild breeze blowing from the river which, with the shade of the tree, made the place they had selected very pleasant.

"This is a jolly place, Rick," said Tom, after they had cooled off. "Now show me what book you brought with you."

"Show me yours first, Tom," was the reply.

Tom laughingly said:

"To tell the truth, Rick, I didn't bring any. I thought the book you would bring would give us enough to read and talk about, so let me see it. I hope it's a good one; for, the day is so hot we won't care to do much walking."

"You're a nice one," remarked Rick, good-naturedly, and then took out of his pocket a book that every boy should read. It was the Arabian Nights' Entertainments.

"That's a jolly book," said Tom approvingly, as he read its title. "Just the book for a hot, dreamy day like this. It contains a lot of splendid stories."

"Have you ever read this book, Tom?" enquired Rick.

"Read it?" was the reply. "I suppose I have read every story in it several times."

"So have I," said Rick. "I like to read them again and again, for nearly every one has a number of shivers and creeps in it."

"What do you mean?" asked Tom, laughing, "by a story having shivers and creeps in it?"

"Why, don't you remember the fairy story of a man who wanted to shiver, and tried to meet all kinds of horrible things, so that he might enjoy a good shiver?"

"Yes," said Tom, "I remember it, but what has that to do with stories in the Arabian Nights?"

"Well," said Rick, "the stories in the Arabian Nights are told so well, and seem to be so real, that you shudder whenever the hero or the heroine is in danger, and then again you thrill with pleasure when they escape these dangers. There's no going to sleep while reading such stories."

"Oh, now I understand you," said Tom. "Yes, that's just what such stories do. You might more correctly say that each story contains shakes or shivers between nearly as many thrills."

"Tom," said Rick, "who wrote the Arabian Nights, do you know?"

"I don't think any one man wrote them" was the reply. "I believe they are a collection of stories taken from different parts of the world."

"Well, who wrote the best of these stories?" persisted Rick.

"All the stories are so old, Rick, that it is not known who wrote them. Indeed, most of them were old long before the art of printing had been invented."

"How can that be?" enquired Rick.

"Well, this is the way I understand it," replied Tom, "all the world likes to hear a good story. This is so true that in some parts of the world there are men, known as professional story tellers, who make a very comfortable living by telling exciting and interesting stories. This is especially the case in the East, in the Mohammedan countries of Asia, Africa, and European Turkey. Here the professional story teller has collected for his stock in trade, a number of stories based on myths or legends, that have been handed down from one generation to another. The stories are told in the coffee houses, in the streets, in the army, or in the caravans, during hours of relaxation.

"The story teller tells the stories as he walks to-and-fro among his audience. Since he depends for his payment on the small pieces of money he collects from his hearers, he tries as far as possible to bring the different characters in the story into dangerous positions, so that his audience becomes greatly excited and wonders how the dangers can be avoided. He always breaks off abruptly when the interest is greatest, making his escape from the audience and promising to come again the next day to tell the rest."

"Just as they do in the story papers and magazines," said Rick. "Then the stories in the Arabian Nights have been collected from the different story tellers?"

"That is how I understand it," was the reply.

"Then," remarked Rick, "I suppose that the story in the beginning of the Arabian Nights' Entertainments, about the Sultan Schahriar and Scheherazade and Dinarzade, the daughters of the grand Vizier, was made up only for the purpose of an introduction to the stories?"

"I believe so," replied Tom.

"Now, Rick," said Tom, "begin reading, and when you get tired, I'll take a turn."

So Tom settled himself on his side so that he could both hear Rick reading and at the same time enjoy the beautiful panorama that was spread out before him.

"Where shall I begin?" said Rick.

"Suppose you read some of the adventures of that wonderful man, Sinbad, the Sailor. They are chock full of alternate shivers and thrills."

"They are, indeed," replied Rick. "Sinbad could bat them out all right, couldn't he, Tom? Shall I read all of Sinbad's voyages?" he continued.

"No," was the reply, "I guess one will do. Let's hear about the fifth voyage."

So Rick began reading as follows:

"'The pleasures I enjoyed soon made me forget the pains I had undergone, yet they were not sufficiently attractive to prevent my forming the resolution of venturing a fifth time on the sea. I again provided myself with merchandise, packed it, and sent it by land-carriage to the nearest sea-port, where, unwilling to trust any more to a captain, and wishing to have a vessel of my own, I built and equipped one at my own expense. As soon as it was finished, I loaded it and embarked, and as I had not sufficient cargo to fill it myself, I received several merchants of different nations with their goods.

"'We hoisted our sails the first fair wind and put to sea. After sailing a considerable time, the first place we stopped at was a desert island, where we found the egg of a roc, as large as that I spoke of on a former occasion; it contained a small roc, which was just ready to hatch, its beak having begun to make its appearance. The merchants who were with me broke the egg with hatchets, and cut out the young roc, piece by piece, and roasted it. I had seriously advised them not to touch the egg, but they would not attend to me.

"'They had scarcely finished their meal, when two immense clouds appeared in the air at a considerable distance from us. The captain, whom I had hired to have the care of the vessel, knowing, by experience, what it was, cried out that it was the father and mother of the young roc, and warned us to re-embark as quickly as possible, to avoid the danger which threatened us. We took his advice, and set sail immediately.

"'The two rocs approached, uttering the most frightful screams, which they redoubled on finding the state of their egg, and that the young one was no more. Determining to revenge themselves, they flew away towards the part from which they came, and disappeared for some time, during which we used all diligence to sail away, and prevent what nevertheless befell us.

"'They returned, and we perceived that they had each an enormous piece of rock in their claws. When they were exactly over our ship, they stopped, and suspending themselves in the air, one of them let fall the piece of rock it held. By the address of the pilot, who suddenly turned the vessel, it did not tumble on us, but fell close to us into the sea, in which it made such a chasm that we could almost see the bottom. The other bird, unfortunately for us, let its piece of rock fall so immediately on the ship, that it broke and split it into a thousand pieces. The sailors and passengers were all either crushed to death, or drowned. I was myself under water for some time, but rising again to the surface, I had the good fortune to seize a piece of the wreck. Thus, swimming sometimes with one hand and sometimes with the other, still holding what I had fixed myself to, and having the wind and current both in my favour, I at length reached an island, where the shore was very steep; I nevertheless overcame this difficulty, and got on land.

"'I seated myself on the grass to rest from my fatigue, after which I arose and advanced into the island, to reconnoitre the ground. It seemed to be a delicious garden; wherever I turned my eyes I saw beautiful trees, some loaded with green, others with ripe fruits, and transparent streams meandering between them. I ate of the fruits, which I found to be excellent, and quenched my thirst at the inviting brooks.

"'Night being arrived, I lay down on the grass in a convenient spot; but I did not sleep an hour at a time; my sleep was continually interrupted by the fear of being alone in such a desert place, so that I employed the greatest part of the night in lamenting and reproaching myself for the imprudence of venturing from home, when I had everything to make me comfortable there. Day returning with its cheerful light, I arose and walked amongst the trees, though not without some degree of apprehension.

"'When I had advanced a little way in the island, I perceived an old man, who appeared much broken down. He was seated on the bank of a little rivulet; at first I supposed he might be like myself, shipwrecked. I approached and saluted him, to which he made no other return than a slight inclination of the head. I asked him what he was doing, but instead of replying, he made signs to me to take him on my shoulders and cross the brook, making me understand that he wanted to gather some fruit.

"'I supposed he wished me to render him this piece of service; so taking him on my back, I stemmed the stream; when I had reached the other side, I stooped, and desired him to alight; instead of which (I cannot help laughing whenever I think of it), this old man, who appeared to me so decrepit, nimbly threw his legs, which I now saw were covered with a skin like a cow's, over my neck, and seated himself fast on my shoulders, at the same time squeezing my throat so violently that I expected to be strangled; this alarmed me so much, that I fainted away.

"'Notwithstanding my situation, the old man kept his place on my neck; he only loosed his hold sufficiently to allow me to breathe. When I was a little recovered, he pushed one of his feet against my stomach, and kicking my side with the other, obliged me to get up. He then made me walk under some trees, that he might gather and eat the fruit we met with. He never quitted his hold during the day, and when I wished to rest at night, he laid himself on the ground with me, always fixed to my neck. He never failed to awaken me in the morning, which he effected by pushing me, and then he made me get up and walk, kicking me all the time. Conceive, gentlemen, the plague of bearing this burden, without the possibility of getting rid of it.

"'One day, having found on the ground several dried gourds, which had fallen from the tree that bore them, I took a pretty large one, and after having cleared it well, I squeezed into it the juice of several branches of grapes, which the island produced in great abundance. When I had filled the gourd, I placed it in a particular spot, and some days after returned with the old man, when, tasting the contents, I found it to be converted into excellent wine, which for a little time made me forget the ills that oppressed me. It gave me new vigour, and raised my spirits so high that I began to sing and dance as I went along.

"'The old man perceiving the effect this draught had on my spirits made signs to me to let him taste it; I gave him the gourd, and the liquor pleased him so well that he drank it to the last drop. There was enough to inebriate him, and the fumes of the wine very soon rose into his head, so that his legs loosened by degrees. Finding he no longer held me tight, I threw him on the ground, and taking a large stone I crushed him to death.'"

When Rick had finished the story, Tom said:

"That was a great story, Rick, wasn't it?"

"Yes, Tom, but I don't understand why Sinbad should have had any trouble in geting rid of the 'Old Man of the Sea.'"

"I guess the old man was much stronger than Sinbad," suggested Tom, "and then probably he didn't try very hard at first, and at last got too weak to throw him off."

"Didn't the old man fool Sinbad all right," said Rick, "when he sat on the other side of the brook, and persuaded Sinbad to let him get on his shoulders and thus cross the brook?"

"Yes, indeed," said Tom. "Do you know, Rick, that the Old Man of the Sea is not unlike one's bad habits. One can easily take them on, but the longer they are carried the harder they are to get rid of, so that at last they are apt to ruin a chap."

"That's so," replied Rick, "they seem harmless, and quite respectable at first, until you get to know them."

"Yes," said Tom, "I guess the Old Man of the Sea was like that. I can imagine him as being a good looking chap with long gray hair and blue eyes, and such a sanctimonious look that you would think butter couldn't melt in his mouth. Oh, no, he wouldn't hurt Sinbad, he simply wanted to get on the other side of the brook and pick some fruit; so Sinbad thinking no harm good-naturedly took him on his shoulders and then the trouble began. He got rid of him though."

"Tom," said Rick, soberly, "Ralph Coffin met the Old Man of the Sea, and took him on his shoulders, didn't he? His Old Man of the Sea was cigarette smoking. But Ralph tripped him and shook him off and I'm glad of it."

"Yes," replied Tom. "We are apt to give the Old Man a chance to seat himself comfortably on our shoulders, and then carry him with us all the rest of our lives. Rick," he continued earnestly, "if you ever see me ready to take the old man aboard, warn me, won't you? I think it is a shame for a fellow to ruin the chances he may have for success in life by taking on bad habits. You'll do this for me, won't you?" he asked earnestly.

"I will, indeed," replied Rick, "and you'll do the same for me, won't you? There are so many habits that seem at first sight not so bad, that we take them on our shoulders and would afterwards be glad to throw them off, but find it almost impossible. You'll warn me, won't you, Tom?"

"That I will," was the reply.

The boys sat for several minutes thinking without saying anything. But at last, Rick, handing the book to Tom, said:

"Now, Tom, you read a story."

"What shall it be, Rick?" he said.

"Oh, I don't care, Tom. Pick out one."

"All right," said Tom. "Since you give me the choice I will read you the story of the Third Calender."

"What's a calender, Tom?" enquired Rick.

"A begging dervish of Persia or Turkey," was the reply. "I suppose," he continued, smiling, "you know what a dervish is. He is a kind of friar, or member of a Mohammedan religious order. Now listen to his story.

"'I am called Agib, and am the son of a king, whose name was Cassib. After his death I took possession of his throne, and established my residence in the same city which he had made his capital. This city, which is situated on the sea-coast, has a remarkably handsome and safe harbour, with an arsenal sufficiently extensive to supply an armament of a hundred and fifty vessels of war, always lying ready for service on any occasion; and to equip fifty merchantmen, and as many sloops and yachts, for the purpose of amusement and pleasure on the water. My kingdom was composed of many beautiful provinces, and also a number of considerable islands, almost all of which were situated within sight of my capital.

"'The first thing I did was to visit the provinces; I then made them arm and equip my whole fleet, and went around to all my islands, in order to conciliate the affections of my subjects, and to confirm them in their duty and allegiance. After having been at home some time, I went again; and these voyages, by giving me some slight knowledge of navigation, infused such a taste for it in my mind, that I resolved to go in search of discoveries beyond my islands. For this purpose I equipped only ten ships, and embarking in one of them, we set sail.

"'During forty days our voyage was prosperous; but on the night of the forty-first the wind became adverse, and so violent, that we were driven at the mercy of the tempest, and thought we should have been lost. At break of day, however, the wind abated, the clouds dispersed, and the sun brought fine weather back with it. We now landed on an island, where we remained two days, to take in some provisions. Having done this, we again put to sea. After ten days' sail, we began to hope to see land; for since the storm we had encountered, I had altered my intention, and determined to return to my kingdom, but I then discovered that my pilot knew not where we were. In fact, a sailor, on the tenth day, who was ordered to the masthead for the purpose of making discoveries, reported to the right and left he could perceive only the sky and sea, which bounded the horizon, but that straight before him he observed a great blackness.

"'At this intelligence the pilot changed color, and throwing his turban on the deck with one hand, he smote his face with the other, and then cried out, "Ah, sire, we are lost; not one of us can possibly escape the danger in which we are." I asked him what reason he had for this despair. "Alas, sire," he answered, "the tempest has so driven us from our track, that by mid-day to-morrow we shall find ourselves near that blackness, which is nothing but a black mountain, consisting entirely of a mass of lodestone, that will soon attract our fleet, on account of the bolts and nails in the ships. To-morrow, when we shall come within a certain distance, the power of the lodestone will be so violent, that all the nails will be drawn out, and fastened to the mountain; our ships will then fall in pieces, and sink. This mountain towards the sea is entirely covered with nails, that belonged to the infinite number of ships of which it has proved the destruction. It is very steep, and on the summit there is a large dome, made of fine bronze, which is supported upon columns of the same metal. Upon the top of the dome there is also a bronze horse, with the figure of a man upon it; and there is a tradition, sire," added he, "that this statue is the principal cause of the loss of so many vessels and men, and that it will never cease from being destructive to all who shall have the misfortune to approach it until it be overthrown." The pilot having finished his speech, renewed his tears, which excited those of the whole crew. As for myself, I did not doubt that I was now approaching the end of my days.

"'The next morning we distinctly perceived the black mountain; and the idea we had formed of it made it appear still more dreadful and horrid than it really was. About mid-day we found ourselves so near it, that we began to perceive what the pilot had foretold. We saw the nails, and every other piece of iron belonging to the vessel, fly towards the mountain, against which, by the violence of the magnetic attraction, they stuck with a horrible noise. The vessel then immediately fell to pieces, and sunk to the bottom of the sea. All my people were lost; but God had pity upon me, and suffered me to save myself by laying hold of a plank, which was driven by the wind directly to the foot of the mountain. I did not experience the least harm, and had the good fortune to land in a place where there were steps, for there was not the least piece of land either to the right or left, upon which I could have set my foot to save myself. I returned thanks to God, and invoking His holy name, began to ascend the mountain. The path was narrow, and so steep and difficult that had the wind been at all violent, it must have blown me into the sea. I arrived at last at the summit without any accident, and entering the dome, I prostrated myself on the ground, and offered my thanks to God for the favour he had shown me.' "

When he got through reading, Rick smiled and said:

"You are a cunning fellow, Tom. You managed to read a story about magnetism after all, didn't you? Couldn't give the subject up for a single day, could you, Tom?"

"It looks that way," said Tom. "But anyhow, Rick, it aint a bad story, is it?"

"No," said Rick, "except that it is very improbable. I say, Tom," he continued, "you agree with me, don't you? It is not likely that a mass of lodestone even when very large could have such strong magnetic power as to be able to draw the bolts and nails out of ships, so as to cause them to fly through the air and come bang up to the mountain, is it?"

"I don't think it is," said Tom, "still, it's a good story for all that."

"Tom," enquired Rick, "lodestone must be a funny kind of stuff. Have you ever seen any of it?"

"Yes," said Tom, "it's a kind of iron ore, and is of a black color. Let's go down town to-morrow and see if we can get a small piece of it. I think we can buy a piece at Foote's Mineral Store, on 19th Street, near the Academy of Natural Sciences. At the same time, we can take a look at the specimens of minerals in the Academy's collection."

Tom's proposition was agreed to. Next day, the boys bought several small pieces of lodestone and spent a pleasant hour afterwards in examining the mineral specimens in the Museum of the Academy.

They remained on the hill until after lunch, then they took a ramble through the Belmont Glen, for an hour, when they were driven home by a heavy shower of rain.

XXII.

THE BRONSON AND JUSTICE PRIVATE TELEGRAPH LINE

During very warm weather, the boys frequently spent their afternoons in the Park reading and talking. They were active boys, and by no means limited their walks to the neighborhood of Strawberry Mansion. Sometimes they would spend the entire day in the Park, taking their lunch, and very often would extend their walk along the eastern banks of the Schuylkill, either to the upper portions of the Wissahickon, or far up the river beyond the Philadelphia Swimming Club's house. Their favorite afternoon walk, however, was the hill at Belmont, as this was comparatively near their homes.

About the middle of July, something occurred that induced them to spend much of their time in the laboratory. They had not yet visited the power station, since a brief note from Mr. Dodge, acknowledging the receipt of the lightning tube, had informed them that he had been unexpectedly called to the shops of the General Electric Company, at Schenectady, N. Y., where several huge generators were being built for the power house. That this would keep him out of the city for most of the time until late in August, when he hoped the boys would call on him.

One day, Tom called up the Western Union Telegraph Office, on the phone, and was pleased to learn that Mr. Gordon would be able to see them for half an hour that afternoon at three o'clock.

Calling promptly at the time mentioned, the boys were at once shown into Mr. Gordon's office.

"Good afternoon, boys," he said, pleasantly, "I am sorry not to have been able to see you before this, but I am a very busy man. Come, I will show you our operating room," leading the way towards an adjoining room.

When the door of the room was opened, the boys were surprised by the roar of ticking sounds that came from nearly one hundred telegraphic sounders, placed on small desks or tables before which operators were sitting.

"Quite a racket, isn't it, boys?" said Mr. Gordon, laughing. And then listening attentively, he evidently picked out the ticking sounds produced by one of the many noisy instruments and said:

"There's an important message for me," and then walking rapidly towards the 6th table on the 2nd row of instruments, he said to the operator:

"I got that message, Jones, but write it out all the same and send it to me in the usual manner. It is very important."

It astonished the boys that Mr. Gordon should be able not only to pick out his message from others among so much noise but also to almost instantly locate the particular table at which it was being received.

"It must have taken you a long time to learn to be able to do that," said Tom.

"It did," replied Mr. Gordon, "but it is not as difficult to read a message at a distance from the instrument in the din of this room as you might think. Nearly all our operators can do this. Our operating room is not unlike a crowded room in which nearly everybody is talking at the same time. While at first the noise of all these instruments may bother one to understand what is being said to him, yet very soon one learns to hear as easy as if his instrument only was sounding."

"But," said Tom, "in a crowded room there is a difference in the voices of the people, while here each instrument produces exactly the same sounds, does it not?"

"No, Tom," was the reply. "The clickings of the different instruments are not alike. When you have learned to receive by sound you find there is as much difference between the sounds of the different instruments as there is between the voices of different people."

Mr. Gordon now showed the boys, among other things, the quadruplex instruments, by which it is possible to send four different messages at the same time over the same wire, two messages in the one direction and the other two in the opposite direction. He also showed and explained to them the operation of an important telegraphic instrument called a relay, in which signals, received over the lines from distant stations, are automatically strengthened by the throwing in of a local battery.

He then took them to the battery room, where the electric current is produced that is employed for sending and receiving signals, and then showed them a telegraph generator or dynamo driven by an electric current that was employed in certain cases for producing the electric currents employed in preference to those produced by batteries.

After the boys had been shown through the building, Mr. Gordon took them back to where they had started, and said:

"Do you understand telegraphy, boys?"

"No, sir," replied Tom, "but I would like to learn about it."

"And so would I," said Rick.

"Do you live near each other?" enquired Mr. Gordon.

"Rick and I live only about one block apart," said Tom.

"Then why don't you learn to send and receive telegraphic despatches, and then string a wire over the roof-tops between your two houses and thus have a private telegraph wire."

"That would be splendid," said Tom, enthusiastically, "but we haven't any instruments."

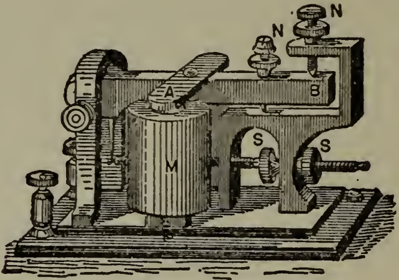
"I can arrange that," was the reply. "We have been putting new and improved apparatus in our station. I was looking over a lot of stuff we are about to sell for old metal. I took out two sets of apparatus for you, as well as several old batteries. Here they are," he said, taking the boys to a corner of the room. "If you care to have them, you are welcome to them."

Though greatly pleased with Mr. Gordon's kindness the boys hesitated to accept so valuable a gift.

"Don't hesitate," replied Mr. Gordon, "to take these things. Their money value is comparatively small, though you can get almost as good service out of them as if they were new. Now sit down a few minutes, and I will show you how to set the apparatus up and charge the battery."

The boys spent a pleasant half hour listening to Mr. Gordon's explanation of the apparatus.

"The Morse sounder," he said, "consists of an electro-magnet, over the poles of which are suspended an armature of soft iron, rigidly attached to a metallic lever. This lever is pivoted at one end. When an electric current flows through the coils of insulated wire on the electro-magnet, as the battery circuit is closed by the telegraph key, the magnet is instantly attracted and draws its armature towards its poles. The armature, however, does not come in contact with the poles, since it is provided, furthest from the pivot, with contact points. On its downward motion, therefore, it strikes against a piece of metal thus producing an audible sound. When the electric current ceases to flow through the coil, as the circuit is broken by the upward movement of the key, the electro-magnet at once loses its magnetism and the armature is moved back by a spring. The to-and-fro movements of the armature and its attached lever produce a succession of clicking sounds that follow one another with a rapidity that depends on the number of times per second the telegraphic key is pushed down and permitted to fly back by the action of a spring.



Morse Telegraphic Sounder

A, soft iron armature of electro-magnet M. B, striking lever, pivoted at one end in adjustable screw pivots, with the motion of its free end limited by two set screws, N, N. S, S, regulating screw, for adjusting spring for pulling the lever B back on the current ceasing to flow through electro-magnet M. As the armature is moved towards and from the poles of the electro-magnet M, the sounds or clicks are caused by the free end of the lever B, striking against the ends of the set screws N and N, respectively.

" The system of telegraphy employed to-day, in America, and for the matter of that, in most parts of the world, is the invention of an American, named Morse. In the original Morse instrument, the striking lever is provided with a metallic stylus or point near one of its ends. This point presses against the surface of a long strip of paper, kept in uniform motion by means of clockwork, makes indentations in the surface of the paper strip as the armature moves towards and away from the electro-magnet. The shapes and arrangement of these indentations depend on the time the current continues to flow through the coils wound on the electro-magnet. If the key is depressed and then almost instantly released, the electro-magnet almost instantly loses its magnetism, so that a dot is made on the paper. If the current is permitted to flow through the coils for a longer time, a stroke or dash is made. These dots and dashes, being separated from one another by spaces corresponding to the times the current is not flowing, produce the well known dot-and-dash Morse alphabet. This form of receiving apparatus is known as the Morse register, and possesses the advantage of registering or recording on the paper fillet all messages sent through the instrument."

As they were about leaving, he said:

"I will call at your laboratory to-morrow afternoon and give you a short lesson in sending and receiving, so get your instruments in place by that time. Put them up first in your laboratory, as far apart as you can, and then, as soon as you learn to send and receive, run a telegraph line over the rooftops between your houses, so that you can talk with one another by telegraph."

He then continued:

"I am going to Lafayette next Saturday afternoon for a swim. If you meet me at the clubhouse at that time we can take another swim together."

Tom and Rick were happy boys as they carried two large packages containing the apparatus and batteries to the laboratory, for Mr. Gordon had one of his men wrap them in two convenient bundles, while he had been talking to them. On untying the bundles, at the laboratory, they found that besides the sounders and keys there were not only a lot of wire and insulators for running their line, but also some bluestone, or copper sulphate, and new zincs, for setting up the batteries.

It was near supper time when they reached the laboratory, but they returned after supper and began running their telagraph line from one end of the room to the other. They also set up the battery in accordance with Mr. Gordon's instructions, working so hard that about 9.30 P.M. they had everything in place, and succeeded in sending signals to each other across the room.

Early next morning the boys began practicing sending the different letters of the Morse alphabet, so that by the time Mr. Gordon reached the laboratory they were able to transmit a few of these letters.

"You are doing fairly well, boys," he said, when they made several letters for him. "But you don't make the difference between the dots and dashes plain enough."

He then showed the boys how to send a dot and a dash.

"To send a dot you must push down the telegraphic key for a very short time only and then immediately release it. To send a dash keep the key down for a longer time. Suppose," he said, "you wish to send the letter A, which, in the Morse alphabet, consists of a dot, an interval, and a dash. To send the dot, press down the key for a short time and release it, then, after an interval of the same length as that required to send a dot, again press down the key and hold it for a time three times as long as for a dot."

In the same manner, Mr. Gordon showed them the other letters of the alphabet. For example, the letter B is made by a dash, a short space, and three dots, separated by short spaces. The letters C, O, R, Y, and Z, employ spaces of extra length and are therefore known as spaced letters. L is produced by a dash of twice the length of an ordinary dash. In spaced letters the space of extra length is two dots in length. A dash has a length equal to three dots. The space between adjacent letters is equal to three dots and that between adjacent words to six dots.

AMERICAN MORSE CODE

Alphabet

a ·—
b —···
c ·· ·
d —··
e ·
f ·—·
g — —·
h ····
i ··
j —·—·
k —·—
l ——
m — —
n —·
o · ·
p ·····
q ··—·
r · ··
s ···
t —
u ··—
v ···—
w ·— —
x ·—··
y ·· ··
z ··· ·
& · ···

Numerals

1 ·— —·
2 ··—··
3 ···—·
4 ····—
5 — — —
6 ······
7 — —··
8 —····
9 —··—
0 ——

Punctuation Marks

Period ··— —··
Comma ·—·—
Interrogation —··—·
Exclamation — — —·

There was much to be remembered, and although both boys had good memories, and did very well, yet both, and especially Rick, frequently either forgot how to make some of the letters, or else were so long in trying to remember the exact number of dots and dashes, or the order in which they followed one another, that of course resulted in many errors in the intervals between the successive signs.

"What a splendid thing it would be," said Rick to Mr. Gordon, "if one could never forget."

"I am not so sure of that," said Mr. Gordon, laughing. "While it is of great advantage to be able to remember things, yet it is often equally advantageous to be able promptly to forget them."

"I don't see how that can be, Mr. Gordon," replied Rick.

"Take the electro-magnet on the sounder," was the reply, "as you probably know its core is made of soft iron. Now the proper operation of this instrument not only depends on its ability to remember that it has been magnetized, but also to be able to forget with equal rapidity that it has just been magnetized. The electro-magnetic telegraph would not operate if its electro-magnets were not able both instantly to acquire and instantly to lose their magnetism, as the current passes through or ceases to pass through their magnetizing coils."

"That's so," said Rick, "but nevertheless, I wish I could never forget those things I want to remember, and what I want to remember now are the exact characters that form the letters of the Morse alphabet, and the order in which they follow one another."

"Keep at it long enough," was the reply, "and you will soon be unable to forget, or, what is still better, you will be able to remember without trying to do so. Indeed, until the characters of the Morse alphabet come to you without trying to remember them, you won't be able either to send or to receive telegraphic despatches."

"Mr. Gordon," asked Tom, "how many words can you send over the telegraphic line in a minute?"

"About forty or fifty," was the reply. "I have sent as many as fifty-three words per minute."

"Tom," said Rick, "I wonder whether we will ever be able to send a despatch of fifty-three words a minute?"

"I think you will, boys," said Mr. Gordon, "but to do this requires long practice, and don't forget that while you are learning you should rather try to send distinctly and clearly than to send rapidly."

Mr. Gordon became so interested in the boys that he gave them many lessons. Under his excellent teaching they were both able by the middle of August, to send and to receive without difficulty.

That Saturday afternoon, Tom and Rick met Mr. Gordon at the clubhouse at Lafayette, and had a splendid swim, during which they practiced the crawl swimming stroke. Mr. Gordon showed them the difference between the double over-arm breast-stroke, and the over-arm side-stroke, explaining how the latter stroke could be kept up without excessive fatigue for much longer than the former.

While dressing, they were surprised to hear, coming from one of Mr. Gordon's hands, clicking sounds like those produced on a sounder.

"How do you do that?" enquired both boys curiously.

"With this little thing called a snapper sounder," and opening his hand he showed them a flat piece of steel so bent that when its ends were pressed together a clicking or snapping sound was produced, that was followed by a somewhat similar sound when the ends were permitted to fly apart.

"This is an excellent way," he said, "to practice sending and receiving. See if you can tell me what this is," operating the sounder so as to produce one letter of the Morse alphabet.

The boys listened carefully and heard sounds corresponding to a dot, an interval, and a dash, when both said:

"A."

"Correct," said Mr. Gordon. "Now tell me what this is," making three clicks corresponding to three dots.

The boys correctly answered:

"S."

In this way Mr. Gordon produced different letters of the alphabet and even short words. It was capital practice and the boys enjoyed it very much. They were especially pleased when Mr. Gordon presented to each of them a snapper sounder, saying:

"When you are walking together, practice sending and receiving. You may sometime find it convenient to talk privately together in this way, since very few people understand the Morse alphabet."

As Mr. Gordon had predicted, the boys found these little instruments of great use in both sending and receiving telegraphic signals, and at last became so expert that when near together, they could hold the instruments in their pockets and talk with each other when the clickings were too feeble to be heard by any one not especially listening for them.

As we shall see in a subsequent chapter, this ability to thus converse privately proved of great value.

XXIII.

A TROLLEY ACCIDENT

One morning during the early part of August, Tom had gone to the laboratory shortly after breakfast and was waiting for Rick, who had promised to meet him. They had both made such progress in telegraphing that they had no difficulty in both sending and receiving messages over their private telegraph line. It was customary for the boys to converse together for a quarter of an hour in this manner, but this morning Rick had agreed to come over immediately after breakfast, so as to try some new experiments. After waiting some time for Rick, Tom went over to his instrument to call him at the house so as to hurry him up. Just as he was going to do this he heard Jamie's voice at the foot of the stair-case, saying:

"I'm coming up, Tom; are you doing tricks?"

"Come in, Jamie," he said, as the little boy appeared at the door. "Come and sit awhile with brother. I'm not doing tricks. I'm talking to Rick with this thing," he said, pointing to the telegraph instrument. "I'm telegraphing to him."

"What's telegaffing?" enquired Jamie. "But mother said, tell Tom to come and see me immediate."

Jamie was so pleased with the big word that he repeated it.

"Yes, mother said come immediate."

"Well then, Jamie," said Tom, "sit on the chair in front of my desk here while I am away. Be sure you don't touch anything, or some of brother Tom's tricks may go off and surprise you. I think Rick will be here soon. When he comes tell him that I will be back in a few moments.”

Tom left the room while Jamie sat in the chair and looked with wonderment on the telegraphic key and the Morse sounder that would permit brother Tom and his friend, Rick, to talk to each other over the house-tops, along a wire he could distinctly see extending directly from the window of the laboratory, to the top of a small house occupied by a Chinese laundryman, and then over two other roofs to the top of Rick’s house.

Jamie had seen so many wonderful things happen in Tom’s laboratory, and had such a wholesome dread of touching anything, that he quietly waited for the coming either of his brother or Rick, of whom he was very fond. After waiting for fully half an hour, he heard the telegraphic sounder on the table begin to click.

“I dess that’s telegaffing,” he said to himself.

The clickings of the instrument kept up for some little time and at last they ceased. After nearly another half hour, Tom’s steps were heard running up to the door. As soon as he came into the room he said:

“Hasn’t Rick came yet, Jamie?”

“No,” said Jamie, soberly. “Rick didn’t come up the stair-case, but I dess he came in over that wire,” pointing to the wire extending over the house-tops. “I dess he’s been telegaffing to you, for that thing,” pointing to the sounder, “made a queer noise, like this,” attempting to imitate the clickings with his mouth.

‘“That’s pretty good, Jamie,” said Tom, laughing. “You didn’t touch anything, did you?”

“No, Jamie didn’t touch anything. Jamie was afraid they’d play tricks on him.”

"You say Rick hasn't been here since I have been away?"

"No, Rick didn't come up the stair-case."

At this moment the telegraphic sounder again began to tick. Tom listened and read the following message:

"Is that you, Tom; where have you been? I tried to get you this morning, but could not."

Tom answered as follows:

"Why don't you come over, Rick? It's an hour after the time you promised to call."

The answer that he received greatly surprised Tom.

"Come over here, Tom, as soon as you can. I was hurt this morning; knocked down by a trolley car. I am in bed where the doctor says I will have to remain for a week or so at the least."

"Gracious," was the answer sent back by Tom, "hope you are not badly hurt. Your right arm and hand are all right, for you sent this message rapidly, and I had no trouble in getting it. I'll come over at once."

As Tom was getting ready to leave the laboratory, his mother came into the room and said:

"Tom, the postman has brought me a letter saying that your Aunt Jane is coming from New York to pay us a visit. I have just time to get to the railroad station to meet her. I have shut up the house. You must look after Jamie while I am gone."

"All right, mother," said Tom. "I'm sorry to say that I have just learned by a despatch over our telegraph line that Rick has met with an accident, and that his doctor has put him in bed, where he will probably be obliged to remain for at least a week."

"That's very bad news, Tom," said his mother, "but I must go at once and meet sister Jane. She is a stranger in Philadelphia, and would be much disappointed if I am not there when the train arrives. As soon as I get back I will call on Mrs. Justice and see how Rick is. In the meanwhile, you and Jamie had better go and ask if you can do anything for them."

"All right, mother," said Tom. "I hope Rick has not been seriously hurt. I don't know what I would do without him, as he is such a splendid fellow and I love him dearly."

As soon as his mother left the room, Tom commenced pulling down the windows, and said to Jamie:

"Come with brother Tom, and let's go over to Rick's house. Poor Rick has been hurt by a trolley car."

"Is he hurted much, Tom?" enquired Jamie, sympathetically.

"I don't know, Jamie; I hope not."

In a short time the boys reached Rick's house, where Rick's father, Richard Y. Justice, Sr., met them at the door.

"How is Rick, Mr. Justice?" enquired Tom anxiously. "Was he hurt much?"

"No, Tom," replied Rick's father. "I'm glad to say that the doctor does not think he has been seriously hurt. This morning shortly before breakfast, he was knocked down by a trolley car as he was crossing the street a few squares from here. Fortunately, he was caught by the fender of the car. The doctor, who has just left him and is talking with Mrs. Justice, believes that the only injury is a bad blow in the left leg below the knee-cap where the fender struck him. He has put him in bed, however, where he says he must stay a week or so, and has forbidden him to stand on his leg before that time."

"Can I see Rick?" enquired Tom.

"I don't believe there would be any objection, but here comes the doctor, let us see what he says." Then, turning to the doctor he said:

"Doctor, this is Tom Bronson, Rick's chum. The two boys almost live together. Tom wanted to know whether there is any objection to his seeing Rick?"

"None whatever," replied the doctor. "You can go straight to his room now, Tom."

"Doctor," said Tom anxiously, "is Rick hurt much?"

"I think not," replied the doctor, "his temperature is quite normal. He is not sick at his stomach, and has his wits about him; so I do not think the brain has been injured. You look like an intelligent fellow, Tom," continued the doctor. "If, while you are with Richard, you find his hands getting hot, or he becomes at all flighty or sick at the stomach, tell some one in the house to send for me and I will come at once. The boy must have received a very severe blow from the car. But," he added, seeing that Tom was becoming alarmed, "he is in splendid physical condition and well developed, and seems to have taken such good care of himself that I do not think he will come to any harm."

Tom thanked the doctor and went to Rick's room where he found Rick in bed.

"I'm awfully sorry, old fellow," he said, taking him by the hand, "to see you in bed. Are you hurt much? How did the accident happen? Tell me all about it."

Rick now began to tell Tom all that happened to him. It appeared that that morning shortly before breakfast, when he had gone on an errand for his mother, while crossing a street on which there were two trolley tracks, he was almost run over by a runaway horse and wagon, that turned suddenly into the street. He escaped from the runaway, only to be struck by the fender of a trolley car that was coming rapidly in the opposite direction. Fortunately, he was caught by the fender, and prevented himself from rolling off by holding to the ropes. The fender, however, struck him a severe blow on the left leg, and shook him up generally, so that he was at first quite dazed, but soon lost that feeling and was now all right again.

"Do you feel sick at your stomach, Rick?" enquired Tom anxiously.

"Hello," said Rick, "that's just what the doctor asked me several times. Well, I'll answer you as I answered the doctor. No, I don't feel sick, unless being hungry may be called sick. Of course, when the doctor, as soon as he got my clothes off, began pulling my leg, and pounding me all over to see if any of my bones were broken, or out of joint, I did feel sick, but now I am only hungry, for I haven't had my breakfast yet, and am now waiting for it, as the doctor promised to have some sent me."

During this conversation Jamie sat quietly on a chair near the bed, looking with great sympathy at him, and when soon afterwards the breakfast was brought in, and Rick began eating heartily, Jamie said with an air of conviction:

"I dess you're not hurted much."

"Why don't you think he is hurt much?" asked Mrs. Justice, who had come into the room.

"'Cause he eats," replied Jamie. "When people are hurted much they don't eat. I 'member, when I was a little boy, and fell down stairs, the doctor wrapped up my leg in pieces of wood, and white cloth, and I did'nt care to eat at all; but Rick eats, so I dess he's not hurted much."

"God bless the dear little fellow," said Mr. Justice, who had come into the room, taking him in his arms and kissing him. "I trust that you are right, Jamie. Tom, what is he talking about?" he enquired.

"Jamie fell down stairs last year and broke one of his legs. He was so badly hurt, both from the broken bone and the shock, that he was sick for a long time, but he has now entirely recovered."

Jamie's favorable opinion tickled Rick greatly.

"Thank you, Dr. Jamie," he said to the youngster. "Your visit has done me lots of good. Don't you think you could have them send me some more breakfast? See, the other doctor only sent me two soft boiled eggs, two rolls, a chop, and a cup of milk. Now, you know this is not enough breakfast for a boy like me."

"Jamie's no doctor," said the youngster, seriously. "Jamie has only come to see Rick." And then repeating his opinion with firm conviction. "But I dess you're not hurted much. I dess you'll get all right soon."

"Thank you for the prognosis," said Rick.

The youngster now thought that Rick was poking fun at him. The word prognosis being, of course, too much for him.

When Mrs. Justice left the room, Tom and Jamie remained with Rick.

"Tom," said Rick, "won't you put an extra length of wire in the circuit of my telegraph key, so that it can be placed alongside me on the bed. I had lots of trouble this morning leaning over to reach it on the little table by my bed. You will find some extra wire in the top drawer of the bureau over there."

Tom soon connected an additional length of wire to the circuit of the key, so that it could be easily taken from the table on which it was generally put, and placed alongside Rick on the bed.

"Now," said Rick, "let's practice a little. See if you can read this message."

Tom had no difficulty in taking it and said to Jamie:

"Sit here awhile and talk to Rick, and I will go over to the laboratory and we can talk with each other over the wire."

Tom left the room and in a short time Rick's instrument began clicking. Jamie listened to it and remarked sagely:

"Dat's telegaffing. Dat's the way it went in Tom's laboratory this morning."

"Yes, Jamie," replied Rick, laughing. "That's telegaffing. Tom and I are talking to each other."

"Does telegaffing mean talking?" enquired Jamie.

"Yes, Jamie, that's what it means. Would you like me to telegraph something to Tom for you?"

The youngster at once commenced laughing and said:

"Telegaff brother Tom to come over here immediate, and tell me a fairy story."

Rick sent the message and instantly the answer came by the clicking of the instrument:

"All right, tell Jamie I'm coming."

"What does Tom say?" enquired Jamie.

"He says he is coming immediate," replied Rick, laughing.

In a few moments, Tom came into the room and Jamie at once called out:

"I telegaffed you, Tom. Now tell me a fairy story. I'm ready for the story."

"All right, Jamie," said Tom, "come and sit on my lap and hear it."

The youngster climbed into Tom's lap and listened intently to a wonderful story Tom told him about fairies and brownies. It was clear to Rick that this was something that Tom did frequently since he did it so well.

"Tom," said Rick, "you are a capital story teller. While I am in bed you must tell me lots of these stories to 'amoose me'."

"Yes," said Jamie, "and I'll come and help listen. Tom knows so many stories," said Jamie, "and tells them to me whenever I ask him, so you get him to tell stories to you, and I will come and help listen."

At this moment Mrs. Bronson came into the room with Mrs. Justice. Tom's mother was pleased to learn that the accident was much less serious than she had supposed. After sitting awhile with Rick, she left the room, taking Jamie with her.

"Good-bye, Dr. Jamie," said Rick, "come again soon. You're an all right doctor. Your visit has done me much good."

As the doctor had predicted Rick's condition of health was so splendid that his recovery was rapid. Nevertheless, the doctor would not listen to his leaving his bed until a full week had passed, and even then made him walk about the room on crutches. During this time Tom was almost constantly with him. Indeed, for nearly all the week Tom stayed overnight and slept in an adjoining room. This came about as follows: When the question arose as to whether or not Rick should have a trained nurse with him, Rick, who heard the conversation, looked at Tom with a grimace and said something to him in a low tone.

"Of course I would," replied Tom.

"What are you talking about, boys?" enquired the doctor, good-naturedly.

"Rick asked me whether I wanted a job as trained nurse, that is, he asked me whether I would stay overnight with him for three or four nights."

"Well," said Mr. Justice, who had come into the room with the doctor, "what did you say, Tom?"

"I said of course I would."

"What do you think, doctor?" enquired Mr. Justice. "Tom is a very careful boy and, being very scientific, is a close observer. He loves Rick as a brother, and I am sure would carry out any instructions you might give him, as well, if not better, than any trained nurse could."

"I am willing you should act as a trained nurse, Tom," said the doctor. "Come into the next room and I will tell you just what I want you to do."

Tom served as a trained nurse to the entire satisfaction of the doctor, who was especially pleased and at the same time surprised, by the carefully prepared report that was handed him on his next visit; for, it not only contained Rick's temperature taken by means of a clinical thermometer that had been left for that purpose, but also additional bits of information not usually contained in the reports of trained nurses that showed considerable thought and ability on the part of the substitute and were of no little value to the doctor.

At the end of a week, Rick's convalescence progressed so far that the doctor permitted him to walk about the room on crutches. It may be mentioned that during the afternoon of Rick's accident, Tom changed the position of the call-bell in Rick's room, placing it near his bed in the next room, and had connected it with a key placed alongside of Rick in his bed, so that he could readily call Tom when he wanted anything.

Jamie was also a frequent visitor in the sick room. No day passed on which he did not come three or four times, so that Rick soon learned to love the youngster as much as if he had been his own brother. Mr. Richard Y. Justice, Sr., and his wife also became greatly attached to Jamie, who was soon as much at home at the Justice house as he was in his own home.

When Rick was entirely convalescent, and was able to walk without crutches, the doctor recommended that he be taken to Mr. Justice's cottage at Atlantic City; for Rick's father, as already mentioned, was wealthy, having built up a large fortune as a manufacturing chemist.

When Rick heard of this plan, he said:

"Father, won't you invite Tom and his brother, Jamie, to come and spend a week with us? I would miss Tom very much if I could not see him for a whole week. Besides," he said, "we wish to go on together learning to send and to receive telegraphic despatches."

Mrs. Bronson was in the room at this time, so that Mr. Justice turned to her and said:

"Madam, I trust you will let both boys spend a week with us at our cottage in Atlantic City. We have plenty of room, and will promise to take good care of them. Indeed, it would be a great favor if you would permit them to come."

"Please to let them both come, Mrs. Bronson," said Rick. "We'll give them a good time, and I would be very lonely without them."

Mrs. Bronson, who felt sure that the boys would be carefully looked after, did not hesitate to accept Mr. Justice's kind invitation.

XXIV.

ATLANTIC CITY, N. J.

Tom, Jamie and Rick had a glorious time at Atlantic City, N. J., which they reached on Monday about 11 A.M., and from which they did not return until about noon on the following Monday.

It was now about ten days since Rick's accident. His injured leg was almost as strong as the uninjured one, so that he was able to not only walk without crutches, but also to run, row, swim, and do all the other things a healthy boy is apt to do at a place like Atlantic City. They had gone down with Mrs. Justice, Mr. Justice being so busy that he could not join them until about 5.30 in the afternoon.

Jamie, who had never seen the ocean, was repeatedly asking questions as to how big it was, how it looked, etc. When they crossed the Delaware on the ferryboat to take the cars at Camden, he enquired:

"Tom, is the ocean as big as this river?"

"Yes, Jamie, much bigger. It is so big that when you stand on the shore you can't see across to the other side."

"That's very big, Tom," said Jamie, opening his eyes wide with astonishment, "I'm glad I'm going to see the ocean."

"Won't you be afraid to go in bathing in so big a bathtub, Jamie?" enquired Rick.

"Not if you and brother Tom come in with me, for I know you wouldn't let Jamie be drowned," was the reply in a confident tone. "I say, Tom," he continued, addressing his brother, “is the water of the ocean good to drink?”

“No, Jamie, it is too salt,” was the reply.

“What makes it salt?” enquired the youngster.

Without waiting for Tom’s reply, Rick said:

“Some one upset a big salt cellar in it and that made it too salt to drink.”

Jamie did not say anything, so that both boys thought he had not given any attention to Rick’s answer, but, as is often the case with bright youngsters, they were greatly mistaken, as will afterwards be seen.

They found plenty to do to answer the questions the lad was continually putting to them as they passed through different parts of New Jersey. When at last the train passed over the bridge across the Thoroughfare, and reached Atlantic City, which is situated on an island, Jamie enquired:

“Is this the ocean, Tom? Why, this is not as big as the Delaware.”

“No, Jamie, we haven’t reached the ocean yet, but you will see it in a few minutes.”

One of Mr. Justice’s carriages met them at the station, taking them to the cottage, a beautiful house, situated about two blocks from the ocean. After the visitors had been shown to their rooms, Jamie was so anxious to see the ocean, that Tom and Rick took him to the boardwalk where he got his first view of this great body of water.

“My, ain’t it big?” he said, opening his eyes in wonderment. “What are all those people doing, Tom?” he asked, pointing to the bathers, for this being the bathing hour the beach was crowded.

“They are taking a bath, Jamie.”

“Tom,” said Rick, “the doctor wants me to bathe in the surf. Mother seldom goes in, so we need not wait for her. Our bath house is near here. Let's take Jamie in and give him a bath. I have a bathing suit that will fit you, and can get one for Jamie. Would you like to take a bath, Jamie?"

"I dess so," said Jamie, somewhat awed by the great size of the ocean, "if you and Tom come in with me."

"All right then," said Rick, "come along."

They were soon in their bathing suits, and walking down the beach, entered the water with Jamie, each boy holding on to one of his hands.

It was funny to watch Jamie's face which both boys were doing. It was evident that while he was in dread of the water, yet at the same time he was determined to get into it, so pressing his little lips firmly together, with a look of determination, he walked boldly into the water, tightly holding the hands of Rick and Tom. When at last they had waded in until the water was near Jamie's knees, instead of clinging more tightly to their hands and begging to be taken back he said:

"Rick, please let go my hand. Tom, you hold on tight."

As soon as Rick released his hand, Jamie gravely dipped his little hand into the water, and put it to his lips, tasting it, and said:

"I dess you're right, Rick, it *is* salt. My, what a big salt-cellar that must have been."

Both boys shouted with laughter, since they had no idea that the little fellow had remembered what Rick had told him as to the cause of the saltness of the sea.

"Another philosopher in the family, Tom," shouted Rick.

"Now then, Jamie," said Tom, "let us wade further out and let the breakers reach us."

"All right," said Jamie, bravely. "Rick, take my hand now and hold it tight, and, Tom, don't you let go."

A big breaker was now approaching, when Tom, wishing that his little brother should learn to enjoy a surf bath, told Rick to let go his hand for a moment, when he lifted Jamie up so that only the lower part of his body was wet.

Instead of being frightened, Jamie yelled with delight. They now went a little further out, the boys permitting the water to break more and more nearly over the youngster, until at last he lost all fear, even when the water completely broke over him. Indeed, as soon as he could get his breath, when the water left him, he begged them to "div me another breaker."

That first bath was greatly enjoyed by Jamie. All the rest of the day he kept telling Mrs. Justice about it, and when Mr. Justice came down in time for dinner, and said:

"Well, Jamie, what have you and the boys been doing to-day?"

"We tooked a bath in the ocean, and I know the ocean is salt 'cause I put some in my mouth and tasted it."

After lunch they left Jamie with Mrs. Justice who wished him to take his usual afternoon nap.

"Tom," said Rick, "let's take a walk on the boardwalk towards the inlet. We may afterwards take a row on the Philadelphia that you expected to spend all the summer at a great place for seeing who's in town."

As they drew near the inlet they were surprised to see Ralph Coffin approaching them.

"Hello, Ralph," exclaimed Tom, "it is awfully jolly to see you here. I thought you told me when you left Philadelphia that you expected to spend all the summer at Asbury Park?"

"So I did," replied Ralph, "but my people concluded to spend a week here before returning home. We came a few hours ago, and expect to return on Monday."

"Glad to see you, Ralph," said Rick. "Where are you stopping?"

"At a cottage on Florida Avenue with one of my aunts. I say," he continued, addressing the boys, "I'm in luck to meet you here, I'll have a great time. Where are you staying, Rick?" he enquired.

"Father has a cottage here, and Tom and his brother Jamie are staying with us. Come over to-night, and take dinner with us. We will be glad to see you. We dine at six o'clock. No dress suit affair," he said, laughing. "But what are you going to do this afternoon?"

"I was taking a walk," replied Ralph, "to see if I could not find something to do."

"Tom and I are going to take a rowboat and spend an hour on the Thoroughfare, and then take a swim. We had a bath in the breakers this morning, but I don't call that a swim. O course, you will come along with us."

"I certainly shall. I say, Tom, what have you and Rick been up to lately in the scientific line? Of course, you have been up to something new."

They told Ralph of their visit to the telegraphic station, and Mr. Gordon's present of the Morse sounders and the voltaic batteries. Ralph was surprised to hear that already both had learned to send and receive, and was especially interested in the account of the Bronson-Justice Private Telegraph Line, extending over the rooftops between their houses.

"See what I have lost by leaving the city," said Ralph, in a regretful tone. "I might have been a telegrapher by this time. But I'll take it up when I get back to the city. You'll teach me all about it, won't you, boys?"

"Sure," replied Rick.

They hired a boat with two pairs of oars and a rudder, Tom and Ralph taking the oars, and Rick steering.

While rowing, Tom said:

"Ralph, have you heard about Rick's accident in Philadelphia? He was knocked down by a trolley car, and had to stay in bed for a week, and afterwards walk for several days on crutches."

"Why, Rick," exclaimed Ralph in astonishment, "you are not the kind of fellow to be knocked down by a trolley car. Were you some sleepy countryman this might have happened; but for a wide awake boy like you to get knocked down surprises me. Tell me all about it."

Rick then told Ralph all about the accident, and closed the account by saying:

"But I'm all right now."

They had a pleasant row, but, since the tide was running out, the boat, on two different occasions, grounded on the soft black mud on the bottom of the Thoroughfare. Fortunately, however, they were able each time to push the boat off into deep water.

"That's lucky," said Ralph. "It would not have been pleasant to have had to remain here until the next high tide floated us off."

"It would not indeed," said Rick, laughing, "for instead of eating a good dinner, the mosquitoes would have had a dinner on us."

After their row, the boys had a glorious swim in the channel along the beach at the outlet of the Thoroughfare, going first to Rick's bathhouse and getting bathing clothes. While in swimming they taught Ralph some of the new strokes Mr. Gordon had taught them on their last visit to the clubhouse of the Philadelphia Swimming Club.

While dressing after their swim, Ralph said:

"Tom, I suppose you and Rick have not been making any more experiments with the Franklin kite, have you?"

"No, Ralph," was the reply, "but while I was in the water, I was thinking of a splendid experiment we might make with a kite here."

"Tom Bronson?" exclaimed Ralph, with a mock show of astonishment, "you're surely not dreaming of again trying to draw electricity from the clouds. Remember your promise to Mr. Alexander."

"Don't you worry yourself about that, my boy," was the reply. "This experiment is an entirely different matter."

"Let's hear it, Tom," said Rick eagerly, who knew by experience how splendid Tom's experiments generally were.

"I was wondering," said Tom, "if we made a big kite, say seven or eight feet high, and raised it when the wind was high, by means of a strong string, whether the kite would not be able to pull us after it through the water. I say," he continued, "would it not be splendid to lie in the water on your back and let the kite drag you through it? What do you think, Ralph," he said, turning to him, "do you think it would work? I remember you are well up on kites."

"Your idea is all right, Tom," was the reply. "Let's make an eight foot kite and try the experiment to-morrow afternoon."

It was agreed that this should be done, and that Ralph should come to the Justice cottage next morning, immediately after breakfast, to help make the kite.

As it was only about five o'clock when they returned to the house, they took Jamie out for a short walk, taking him to the merry-go-round. Jamie, who, like many children, had become greatly interested in the Roosevelt bears, mounted a gorgeously painted bear on which he wished to ride, Tom and Rick standing on each side of him in order to keep him from falling off. They afterwards took him to a penny-in-the-slot machine, Tom giving him a penny for this purpose. The youngster was much amused when, on dropping the penny in the slot, a music-box began playing, especially when, at the close of the music, a card was thrown out with his weight printed on it. Jamie carefully put this card away in his pocket saying that he would show it to his mother when he returned to the city.

Early next morning the boys met at the Justice cottage and began building the big kite. The sticks were made of slender strips of strong oak. The frame was covered with a double sheet of strong tissue paper. As Jamie wanted to take another surf bath, they went out with him at eleven o'clock. As soon as they again returned to the house with Jamie they again started in on their kite and finished it shortly after lunch. Early in the afternoon donning their bathing suits, they started with their kite to the Thoroughfare.

A procession of three boys in bathing suits, carrying a huge kite, attracted no little attention, many people stopping to ask what they intended to do with it, and in some cases, after hearing what the boys had in mind, following them.

Under Ralph's skilful handling, the kite was soon raised high in the air by a strong wind that was blowing from the southwest. The spot they had selected for this purpose was at some distance from where they intended to enter the water. This was done so that the kite would pull them in the direction in which the channel extended.

While they were holding their kite ready to go into the water, they were surprised and pleased to see Mr. Alexander standing among the crowd of people who had gathered to see the experiment.

"Hello, Tom?" he cried in a good-natured tone, another kite experiment? You surely do not intend to try to bring electricity again from the clouds?"

"No, Mr. Alexander," replied Tom, "we are going to see whether the kite will pull us through the water."

"Well," replied Mr. Alexander, "I suppose you can all swim."

"You need not be afraid of that, sir," said one of the by-standers. "I saw those boys in the water yesterday. I never saw better swimming."

"All right then, boys," said Mr. Alexander. "I will follow you and see the experiment tried."

On entering the water the boys found that the kite drew all three after it at a fairly rapid rate, for the wind had greatly increased in strength. The people ran along the shore following them and applauding the ingenious manner in which they had made the kite tow them after it. The direction of the wind was such that it would have carried them across the northern part of the Thoroughfare. Before reaching this point, however, they managed, after some difficulty, to drag the kite after them to the shore, where they pulled it in.

"Let's take another tow, Rick," said Tom, as they were walking back with Mr. Alexander towards the place where they had raised the kite.

"I'm willing," said Rick. Then turning to Mr. Alexander he said:

"How long do you expect to stay here, sir?"

"I leave on the morning train," he replied.

"Won't you come and take dinner with us this evening, Mr. Alexander?" he enquired. "I would like you to

THE KITE DREW ALL THREE AFTER IT AT A FAIRLY RAPID RATE

meet my father and mother. I have often spoken to them about you. It's all right," he said, seeing that Mr. Alexander hesitated to accept an invitation to dinner. "Both father and mother like me to invite my friends to the house. We dine at six, sir," he said.

"I'll call at five-thirty," was the reply. "We will talk about staying to dinner afterwards."

"That'll do," replied Rick. "In that case I know you'll stay, for both father and mother will be sure to repeat my invitation."

The boys again succeeded in raising their kite and having another ride through the water. This time, however, they had so much difficulty in pulling it in at the end of the route, that they concluded not to try another kite trip, as Rick called it.

The remainder of the week was spent in various ways. The boys gave a part of each morning to Jamie, never failing to give him a surf bath. He was such a plucky little fellow that towards the end of the week there was generally a crowd of bathers around watching the manner in which he would stand to catch the breakers, at times actually diving through them, for under Tom, Rick and Ralph's instructions, he had, after a fashion, actually learned to swim.

One afternoon they planned to give Jamie a trolley ride along the beach from their cottage to Longport, a distance of about seven miles. Here they saw the automobile races, the track for this purpose being the hard sand of the beach. A great crowd of people had collected not only from Atlantic City, Longport, and Ocean City, but there were also big excursion trains from Philadelphia and New York.

In this motley crowd, the boys noticed two wicked looking Italian men, who on several occasions tried to attract Jamie's attention, but always slunk away when they saw the boys looking at them. During one of the races, in which a number of closely matched high-power automobiles had been entered against one another, the boys became so interested that for a moment they lost sight of Jamie. In a few moments, however, looking at him they found that the two Italians had again approached the lad and were trying to take him by the hand and lead him away from them. As the boys ran up the two Italians again dropped Jamie's hand and disappeared in the crowd.

"What were those men saying to you, Jamie?" enquired Tom.

"They asked me to take a walk with them, and promised to buy me some candy if I would go."

"What did you say to them, Jamie?"

"I said, 'I don't like you. I don't want you to buy me any candy. Go away, or I will call brother Tom.'"

"And what did they say then?"

"They said, 'little boy, don't be afraid. Italian good men and love little boys. Only want to buy you some candy over there, and then we will bring you right back.' But I said, 'go away, or I will call brother Tom, and Rick, and Ralph.' Then they tried to pull me away with them, and you came, and I'm glad."

"Boys," said Tom, "we must keep our eyes on Jamie. I believe those men were trying to kidnap him. You know this has been done lately with several little boys. They steal them and then write letters to their people saying that unless money is sent they will never see their children again."

Tom was very much excited and said:

"I'll keep my eye on those fellows and if I ever see them attempt to touch Jamie I'll either thrash both of them or they will have to thrash me. Jamie, if you ever see those men again, you must not go with them. They are bad men and may take you away, so that you might never see mother, Tom, Rick, or any of us again."

"I'll not go with them, Tom," replied the little chap. "If they come again, I'll scream out loud."

"Well," said Tom to the other boys, "I have had enough of this place. Let's get on the trolley and ride part of the way back, then we'll get off, walk slowly along the boardwalk towards the cottage, and show Jamie some things that are likely to interest him."

After getting out of the car they came to a Gypsy encampment where a number of people, old enough to know better, were permitting themselves to be fooled out of their money by an old woman, who called herself a fortune teller. She pretended to be able to tell their fortunes by tracing the lines on the palms of their hands. There was a crowd of people around the encampment as they passed, so the boys stood for awhile looking on. It happened that at this moment the woman had just finished reading the fortune of one of her customers. Looking up at Jamie, and seeing how richly dressed he was, for his mother spared nothing to make the little fellow look well, the woman at once became much interested in him, and said in a croning voice:

"Come here, my pretty lad, and let me see that little hand of yours, I will read your fortune."

Tom, who was holding on to Jamie's hand, said to Rick:

"Let's see what the old woman will say." And then permitted her to examine Jamie's hand.

"I read good fortune and long life on this hand. But here," she said, pointing to another line in the hand, "is bad fortune. The line tells me that only recently the boy has escaped a great danger. Look out for your brother," she said, turning to Tom, "somebody is trying to steal him away from you. These lines tell me that the next time they may be successful. I will tell you more, and how to escape this danger, if you will cross my palm with a piece of silver."

"Not to-day," said Tom. "Come, Jamie, we must be going."

The Gypsy woman was very angry when she saw that Tom would give her no money.

"I was going to tell you how to save the lad, but if you think more of your money than you do of the safety of your brother, go away, I'll have nothing more to do with you."

Tom felt uneasy at what had just happened. Taking a tight hold of one of Jamie's hands, and getting Rick to hold the other, they walked rapidly away from the encampment, and even afterwards, when they took Jamie in to see the moving pictures, Tom would not let go of his hand, especially when the lights were turned down.

On returning home, Rick told his father about the two men as well as what the queen had said.

Mr. Justice looked grave for a few moments, and then, since his wife was present, being afraid to worry her, said:

"Tom, I wouldn't worry about the old woman's nonsense."

Afterwards, when he got the boys together where he could speak to them without his wife hearing, he said:

"Boys, while there is, probably, a great deal of nonsense in what the Gypsy woman said, yet I don't like what you told me about the Italians, nor about the old woman either. I don't think these people are working together. The Gypsy woman probably knows these Italians and seeing them watching Jamie made a good guess as to what they were up to. Keep your eyes on Jamie and don't let him talk to strangers. I will ask my wife and the people at the cottage here to do the same, but I will do it in such a way as not to frighten my wife."

The boys kept such a close watch on Jamie that nothing happened to him, and they safely returned to the city after having a splendid time. Mr. Justice was so busy that year that he was only able to get down to the shore one or two afternoons during the week, so Mrs. Justice determined to shut up the cottage and return to the city with the boys, planning to visit Atlantic City again during the latter part of September and October, when her husband hoped to have more time to himself.

XXV.

THE KIDNAPPING OF JAMIE

ONE afternoon, several days after their return from Atlantic City, while Tom and Rick were in the laboratory fixing the batteries and adjusting the springs on the sounder, Rick, who happened to look out of the window facing the shop of the Chinese laundryman, cried out in an excited tone:

"Tom, come quickly and tell me if you recognize the men who have just come out of the door of the Chinese laundryman's shop."

Tom ran to the window and looking at them cried out:

"Yes, they are the two Italians we saw on the beach at Longport, who tried to take Jamie off with them."

"That's right," said Rick. "I recognized them instantly. I wonder what they are doing here."

"I don't know," said Tom, "but I shall in a few moments," and rushing to get his hat he ran down the outside stair-case closely followed by Rick. When they reached the street, the wily Italians had disappeared. Stopping for a moment at the laundryman's shop they asked the Chinaman if he knew in what direction they had gone, but the man said he had not noticed.

The boys ran in opposite directions along the street to see if they could catch the men, but without any success. When Tom got to the corner he met a policeman, an efficient officer, who knew Tom well, and frequently stopped a few moments in the laboratory to see some curious experiment. The boys did not know his name, but called him

481, from the number of his badge. It may be stated here, that 481 was not the officer's real number.

"What's the matter, Tom?" cried 481. "Any one been robbing you, or trying to rob you? Let me know and I will help you if I can."

Tom told the policeman the story of the two Italians who tried to take Jamie away with them the day they were watching the races on the beach at Longport, as well as what the Gypsy woman had told them, adding, after he had completed the story:

"While looking out of the window of my laboratory this morning, both a friend and I saw the men coming out of the door of the shop of Ah Lung Sing, Chinese laundryman. The men, looking up, evidently recognized me; for, when my friend and I ran out into the street to catch them, they had disappeared."

The policeman listened attentively and said:

"Tom, this looks bad. You can depend on it these men have determined to carry off your little brother. Let's keep our eyes open. I think there is no chance of catching them now, as by this time they are far away. I will go and report the matter to our Lieutenant. In the meanwhile go to the Chinese laundryman and try to find out if he knows them. I think Ah Lung Sing is an honest man, and is not mixed up in this affair. Try to learn all you can about the men, make enquiries on the street, and then tell the story to some older person, preferably a man, who will tell you what to do."

"I'll tell Mr. Richard Y. Justice, Sr., at whose house both Jamie and myself were staying while at Atlantic City," replied Tom.

When the policeman heard Mr. Justice's name, he said:

"Tom, you must excuse me for what I am about to say. What you have just told me makes it all the more likely that an attempt is being made to kidnap your little brother. As you know it is not the children of poor people, or even of those in ordinarily comfortable circumstances like your people, who are stolen, but only the children of those who are very rich. Now these men, who I have no doubt are trying to kidnap Jamie, seeing him around the Justice cottage, believed he was one of the family. Tell Mr. Justice by all means, Tom, that you have seen these men again to-day. I'm glad you've told me about Mr. Justice, since the Lieutenant at the station will now understand the matter much better."

As he finished speaking, Rick came running up to them, and said:

"Tom, I have not been able to come near them." And then speaking to officer 481 he enquired: "Have you seen two Italians running down the street a short time ago?"

"No," was the reply, "but Tom has told me all about it. Both of you had better go and see if you can get any information about the men from Ah Lung Sing, while I go and make a report to our Lieutenant."

The boys went to the laundryman's shop, Tom telling Rick what officer No. 481 thought of the matter. Ah Lung Sing met them at the door and said with a smiling face:

"Want washy, washy. Ah Lung Sing good man, washy cheap."

"No, Ah Lung Sing," said Tom, "do you know me? I live in that house over there," pointing to it. "And this boy," nodding to Rick, "lives over there," pointing to Rick's house. "Don't you remember the day you gave us permission to run a wire over your house?"

"All light," said the Chinese, "I lemember." Then turning to Rick he said: "You live in that big house?

Sometimes I washy for that house." And then turning to a book he pointed proudly to an address, R. Y. Justice.

"Ah Lung Sing," said Tom, "who were the two men you were talking to about half an hour ago?"

"Me not know them well," said the Chinese. "Italians; one called Guiseppe and the other Pietro."

"What did they want?"

"They say where goes that telegraph line over my roof? May we go look at it? I said yes, but come down soon. They went, but didn't come down for nearly half an hour; then they say, who lives over there, pointing to Rick's house, and what's the name of their little boy. I say no little boy lives there, but they laugh at me and say, 'we know.' Then they look around and see you watching them from your worky window, then Guiseppe say to Pietro: 'Look; big brother; lun away quick,' so they lan away."

"Thank you," said Tom, putting a silver quarter of a dollar in his hand. "I will come and see you again."

"Thankee, Tom," said the Chinaman, pocketing the money. "Gleat Ameligan boy, Ah Lung Sing will tell you all he knows."

The boys now returned to the laboratory, and began talking over what had happened, when Ralph, running up the stairs, entered the laboratory, saying, in an excited tone:

"Boys, who do you think I saw running down Ridge Avenue a little while ago?"

"I don't know," said Tom, "unless it was the two Italians who were trying to take Jamie away with them at Longport?"

"That's right, Tom, but how in the world did you guess it? Have you seen them?"

Tom told the whole story to Ralph, who said:

"I was surprised when I saw the men, and made up my mind to catch them, and try to make them tell me what they meant by hanging around this neighborhood. They evidently recognized me; for, although I ran after them for some time as fast as I could, I was unable to come up to them."

"Let's go to the police station, and leave word for policeman 481, what we have discovered since. He should know all about it. Then we will go home and keep a sharp lookout on Jamie."

When the boys entered the police station they found officer 481 in conversation with his Lieutenant. Pointing to Tom and Rick he said:

"These are the two boys I was telling you about. I don't know what this boy has to do with it." And then turning to Tom he enquired:

"Well, Tom, what have you found out?"

Tom then gave a clear, concise statement as to what had occurred. The Lieutenant, who listened carefully and was evidently greatly interested, said:

"I'll put a man to spot the Chinese laundryman, as well as his house. I don't think the Chinaman is in the plot, but I won't leave anything undone. I will also have some one watch the premises of Mr. Justice, and keep a lookout on the youngster. I think from the description you have given me of the Italians, that they are from Chicago, where they succeeded in making a rich man pay a large sum of money for the return of his child who they had stolen." Then turning to the boys he said: "I advise you to tell all this both to Mrs. Bronson and to Mr. Justice."

This the boys promptly did. Mrs. Bronson did not appear to be much alarmed, as she believed the boys had unduly magnified what they had seen. She told them, however, to keep a sharp lookout on Jamie while he was out of the house, and said she would keep a lookout herself. It was quite different with Mr. Justice, however, who thought it a serious matter and advised the boys to keep a careful lookout. He then added:

"Unfortunately, I am called to New York, to-morrow, to be gone for some time. I will stop at the police station, see the Lieutenant, with whom I am acquainted, and find out what he thinks about the matter."

Nothing occurred during the next two days, so that the boys began to feel as Mrs. Bronson did, that they had been mistaken in their suspicions. On the afternoon of the second day, however, after the appearance of the Italians, Mrs. Bronson came into the laboratory while Rick and Ralph were there, and said:

"Why, Tom, I thought Jamie was with you. He told me several hours ago that he was going to the yard to play, and was afterwards coming to see you here."

"No, mother," replied Tom, "I have been here with the boys for nearly two hours, and have not seen anything of Jamie. I remember, however, seeing him playing in the yard nearly two hours ago."

"Oh, well," said his mother, "I guess he has gone over to pay Mrs. Justice a visit. I will go and see."

As soon as his mother had left, Tom said:

"Rick, I am going over to your house to see if Jamie is there. I don't like to hear that he has been out of sight for so long a time."

"We'll go with you," said both boys, who, like Tom, were anxious lest the little chap they all loved so well had been stolen by the Italians.

When they reached the Justice house they found Mrs. Bronson greatly excited; for, the little boy had not been near the house. She began reproaching herself for permitting him to leave her, but added:

"I did not think there was any danger in permitting him to go to the back yard and out of the gate directly up the outside staircase."

"Never mind, mother," said Tom, "we'll find Jamie all right. He may have wandered down the street, and even if the Italians have taken him, we'll get him back some way or other. Stay with Mrs. Justice, or, still better, go back to the house, for Jamie might come home at any moment. Boys, come with me to the police station. We will tell the Lieutenant what has happened. On our way there, we will make enquiries in the neighborhood, and see if any one had seen either of the two men. Good-bye, mother, be brave," he added.

On leaving his mother, Tom went with his two boy friends into the street. He had been hiding his anxiety as far as possible from his mother, so that as soon as he got into the street he could with difficulty keep back the tears, but he said bravely to the boys:

"I won't play the baby now. I'll find out where Jamie is if I have to walk the streets of the city all night."

"And we'll help you," said the two boys.

"What is the best thing to do first?" asked Tom. "I guess we will go first to the police station."

As Tom started for the station at a rapid gait, Ralph, who was a cool-headed lad, who seldom permitted himself to get excited, caught Tom by the arm as they were passing one of the Bell Telephone pay stations and said:

"Come in here, Tom. You can talk with the station at once and thus save ten minutes or so. Give the Lieutenant the principal points now, and tell him the rest afterwards at the office."

They did not have any difficulty in getting the police station, and Tom, who was soon in conversation with the Lieutenant, said:

"This is Tom Bronson. I told you the other day that the two Italians who tried to take my little brother Jamie with them when on the beach at Longport, N. J., had been in Philadelphia coming out of the door of the Chinese laundryman, whose house is back of our house. Mr. Richard Y. Justice has also called on you with reference to this matter. Now, brother Jamie has been missing for the last two hours or more. I only learned of this about five minutes ago, and want your advice as to what is best for me to do."

"I remember the case," said the Lieutenant, "and am glad you called me on the phone, instead of waiting to come here. In a case like this every moment counts. I regret that two hours have passed since the boy disappeared, for by this time the men have probably placed the little fellow in a safe hiding place. I will send a description of your brother and the two men to all police stations in the city, so that inside of the next two hours, there will be several hundred policemen on the lookout for the boy or the men."

"Do you want a description of Jamie and of the two men?" asked Tom.

"No," was the reply, "I got that description long ago. But wait a moment," he said, "do you remember how Jamie was dressed this morning?"

"Yes," said Tom, who at once gave the Lieutenant an excellent description of both Jamie and his dress.

"That will help us very much," said the Lieutenant, and then after thinking he said: "Is anybody with you, Tom?"

"Yes," replied Tom, "two of my boy friends."

"Good," replied the Lieutenant, "go with them carefully over all the neighborhood, and enquire whether either the men or the boy have been seen. Then stop at the nearest telephone station and tell me the particulars. Afterwards, call on me here. Don't let them keep you waiting in the outer office, but ask them to send you immediately to me."

As soon as Ralph had learned what the Lieutenant had advised, he suggested that the neighborhood be divided into three sections, and one given to each boy, with the understanding that they were to meet as soon as possible afterwards in Tom's laboratory.

After some fifteen minutes they all assembled at the meeting place, reporting that nothing had been seen either of the boy or the men.

"Well," said Tom, "we have nothing to report at the police office. Let's go and see Ah Lung Sing again."

The Chinese at once recognized Tom, not only because he had frequently seen him going up the steps of his laboratory, but especially as the boy who had put a quarter of a dollar in his hand.

The acute Chinaman at once saw that Tom looked worried.

"What matter, Tom," he enquired. "Something long?"

"Brother Jamie is missing and we have not seen him for more than two hours."

Without waiting to be questioned the laundryman excitedly said:

"Two Italians, Guiseppe and Pietro, here to-day. Blought calliage with them but left it alound the corner. Wanted to go on loof to look at wire. Said can't go. Then they asked after the little boy who lives over here," pointing to Rick's house, "but I said nothing and slammed the door in their faces, and pretended to go back to washy. But I peeped through the blinds. They went alound the corner and so I go back to washy. Half an hour afterwards, I heard talking in the street, and calliage dlive off fast."

"In which direction did it go?" asked Tom, eagerly.

"That way," answered the Chinese, pointing in the direction of the Park.

"Do you remember the appearance of the horses, driver, and the carriage?" asked Ralph.

"Yes, close calliage, two horses, one white, one gray. Dliver looked queer. Hat pulled down all over eyes, much supplised me, 'cause day hot."

"Let's go down the street towards the Park and enquire if such a team has been seen," said Tom. "If it was driving rapidly some one will have been sure to have noticed it."

Enquiries disclosed the fact that several parties had seen a closed carriage, whose driver and horses agreed closely with the description given by the Celestial. But the most exact information was obtained when they met some ten or twelve of Tom's boy friends, coming from the Park, where they had been playing a game of ball. Tom, who knew by experience that most boys are close observers, and seldom allow anything worth seeing to pass unseen, said to them:

"Boys, you know my little brother, Jamie?"

"Sure," said one of them. "A bright little youngster." And then, seeing at once how anxious Tom looked, added: "I hope nothing has happened to him, Tom."

"I fear," said Tom, "indeed, I am almost sure, he had been kidnapped."

"Tell us all about it, Tom," said the boys eagerly. "Perhaps, we can help you."

Tom told them what had happened, describing the appearance of the horse and carriage and its driver, with his face all muffled up.

As soon as Tom had finished this description, two of the boys looked at each other significantly, and then turning to Tom one of them said:

"Both of us saw that team, Tom, driving rapidly down the street. We thought we heard a child's voice screaming in the carriage, but we were not certain, as there were a lot of kids kicking up a racket in the street, so we kept on our way towards the Park."

This information coming as it did after what they had already learned convinced Tom that Jamie had been carried off by the Italians. Turning to the boys he said:

"Won't you run around, boys, and see if anybody else saw that team?"

The boys instantly scattered in all directions. Not long afterwards, a boy, who had gone in the direction of the ball field, came back with another boy whom Tom recognized as Abe Levy. Abe, who had been given a holiday from his work, had been playing ball and was on his way home when the boy met him.

"Tob, I ab awfully sorry to hear your brother Jabie has disappeared. I do that he has beed kidapped, for I dot odly saw the carriage, horses, and the driver, but I saw Jabie idside the carriage as it passed be at a rapid gait. Ode of the curtaids flew up add I got a bobetary gladce at Jabie. There was a womad and a mad idd the carriage alodg with Jabie. Jabie recogdized be, for I heard hib cry out, 'Abe.' He didn't look frighteded, so I thought he was takidg a carriage ride and was calling out to be id fud, so I thought do more about it, and wedt to the Park, but whed these boys told be about Jabie, I rebebered what I had seed, and cabe at wudst to tell you."

"You are sure you saw Jamie?" asked Tom.

"Quite sure," replied Abe. And then turning to the boys who had brought him to the Park he said: "We'll go and see if we cad fidd ady traces of the teab and driver. There's a little chadce of fiddidg the bad, but we ought to be able to fidd the teab, for it is dot so easy to disguise a carriage and two horses. If we fidd out adythidg, Tob, I'll cobe and tell you." With that he started off at a run in the direction he had seen the carriage go."

As the boys disappeared down the street, Tom said to Rick and Ralph:

"Let's go to the nearest telephone office, and tell the Lieutenant what we have learned."

They soon got the Lieutenant and told him the news. He listened attentively, especially to the description of the team, its driver, and the fact that the boy was with a man and a woman; he then said:

"Come at once to my office, boys, I want to talk with you."

When the boys entered the office, they found they were expected, for they were at once shown into the private office of the Lieutenant.

"You've done splendid work, boys," said the Lieutenant. "If any of you want extra work sometime as private detectives, I will be very glad to employ you. What you have discovered gives me a clew that may lead to our finding the youngster. I have sent a description of the team, driver, and the fact that the boy was with a man and a woman all over the city, so that they may be caught before they get the boy in hiding, although I fear it is now too late to do this. Of course, there's no doubt now but that your brother has been kidnapped." And then turning to Rick he added: "Please ask your father to come over to my office. I want to talk with him about this case."

"Father is in New York," said Rick, "and will not be back for several days."

"That's very unfortunate," was the reply. He then sat silently thinking for a few moments, when again turning to Rick he said:

"In a day or two a letter will be received at your house either from the Italians, or from some of their gang, demanding money and threatening Jamie unless a certain amount of money is left at some place they will describe. Now, listen carefully to what I am going to tell you. Do not permit any person to answer this letter, or to leave money as requested, until that letter is shown to me. You must be very careful what you do during the next few days. There are sure to be a number of people in this plot, and not only the house, but all of you will be watched. When, therefore, the letter comes, try to arrange some plan by which I can get it without any one knowing it has been sent to me."

After thinking for a few moments, Tom said:

"I have it, Rick. As soon you receive the letter mail it to Ralph's address, and Ralph can take it immediately to the Lieutenant."

"Good," said the Lieutenant, "but don't mail it at any of the boxes near your house. Take a good long walk, and drop it in a box when you think no one is watching you." And then he added: "Don't mail it to the police station, but mail it to this address," he said, handing Rick a piece of paper on which an address was written. "Now," he continued, "read it yourself and show it to the other boys."

When the boys had read it, he said: "Can you remember it, boys?"

"We'll not forget it," was the reply.

"Then let me have the piece of paper," he replied. And striking a match he held it in the flame, until it was completely consumed.

"Now," he said, turning to the boys, "there is nothing more you can do for the present, but to keep your eyes open and see if you can find any traces of the driver of the team. If anything happens, and you want to communicate with me, don't come to the police station, and don't use the telephone any more, but go to the address I gave you on the piece of paper. You will find me there every day at nine in the morning, and five in the afternoon. Remember, all you boys will be spotted by the gang, and much that you do and wherever you go will be known to them."

As the boys left the police station, Ralph said to Tom:

"Tom, we'll keep our eyes open for the next few days. If either of the Italians do the spotting they may find it dangerous."

"That's so," said Tom, "I'd like to meet either of them. Don't I wish they would come into my laboratory some time."

On returning home, Tom found his mother crying bitterly; for, of course, nothing had been heard of Jamie, and when Tom told her all they had learned and what they had done, she only cried all the harder.

"Cheer up, mother," said Tom, "the Lieutenant is an able man, and the police force of the entire city are now looking out for Jamie. Besides, I am going to start all the boys on the lookout to-morrow, so that I would not be surprised if, before long, we will in some way get news that will enable us to find him."

XXVI.

THE ADVENTURES OF JAMIE. THE DISCOVERY OF THE TAPPED TELEGRAPH LINE

But let us now go back to Jamie so as to see what had happened to him. He had spent the early afternoon in the house with his mother, when, growing tired of remaining inside, he said:

"Mother, may I go and play in the yard a little while, and then go and stay with Tom in the laboratory?"

"Are you sure Tom is in the laboratory, Jamie?" asked his mother.

"Yes, I looked and saw Tom, Rick and Ralph in the laboratory. I think they are doing tricks, so I will play a little while in the yard and then go see them."

As Jamie would be safe in their yard, and would only have to go out of the back gate, and walk a few feet to the foot of the outside stair-case to join Tom, his mother said:

"All right, Jamie. Be sure to ask brother Tom to bring you back home, when you leave the laboratory."

"I will, mother," he said, kissing her.

"I wonder why Tom and mother are so afraid of somebody wunnin' off with me. I won't give them any chance," he said, as he toddled off to the yard.

After playing for half an hour in the yard, he said:

"Now I will go tippty-toe up the steps and s'prise them."

Before he got to the foot of the stair-case, a fairly well dressed woman coming down the street stopped him and said:

"Little boy, is your name Jamie?"

"Yes," said Jamie, "dat's my name. What you want?"

"Jamie," said the woman, "have you a brother named Tom?"

"Yes," said Jamie, "brother Tom's up there," pointing to the second story of the laboratory. "I see him half an hour ago looking out the window."

"No, Jamie," said the woman, "you are mistaken. While coming down the stairs to see you, Brother Tom fell and hurt himself and was taken to the hospital. Your mother has gone there and asked me to come and find you and tell you to come with me. I have a carriage waiting for you around the corner."

"Dess I will do and see mother first," said Jamie, drawing back from the woman, whose looks he did not like. "She's in the house."

"She's not there now, my little dear," said the woman. "Remember you played in the yard for some time, and while playing, Brother Tom was hurt. Your mother went to the hospital to see Tom and asked me to be sure to bring you to her."

"Is Tom hurted much?" enquired Jamie, anxiously.

"Yes," said the woman, "and your mother wants you to come at once."

"Then," said Jamie, anxious to see his mother and brother, "I'll go with you."

The woman led Jamie quickly around the corner to the carriage, opening the door and pushing him into it immediately followed. As soon as Jamie got in the carriage he recognized the man as one of the Italians, and tried to cry out.

"Brother Tom, help me," but before he could speak, the man seized him roughly, held a dirty handkerchief in his mouth, while the woman shut the door and the carriage drove rapidly down the street, the man saying to the boy:

"No makee noise, or Italian man kille you."

Though greatly frightened, Jamie was smart enough to sit still until at last the Italian removed the pocket handkerchief from his mouth. He then peeped through the side of the carriage curtain, until the carriage passed some children, who were playing in the street. Here he almost immediately spied Abe, and, recognizing him, pulled up the shade and cried in a loud voice:

"Abe," when the man instantly placed the handkerchief to his mouth, saying fiercely:

"Calle again and Italian man kille you."

The frightened child now sat still while the carriage was driven rapidly away. Jamie could not tell in what direction it was going, since the blinds were now drawn down tightly. They were, however, evidently driving through the city, for the wheels rattled as they moved over the stones in the streets, and especially when they passed over the trolley tracks at the street crossings. After they had driven for about half an hour, the man suddenly placed a handkerchief containing chloroform over Jamie's nose and mouth. The poor little fellow struggled and tried to get it away from his mouth, but the man held it there tightly and soon Jamie lost all consciousness.

After a long drive the carriage stopped before a broken down frame house, in a dirty little street extending east and west in the southern part of the city. Taking Jamie in his arms, the man entered the door of the house, saying to some people who stood around the steps:

"Poor little boy sick. Sun too hot. Will take him upstairs and give him good sleep."

None of the people appeared to be surprised at Jamie's condition, especially, since, as soon as he had lost consciousness in the carriage, the woman had taken off his pretty clothes, and dressed him in dirty, shabby clothes like those worn by most of the children of that neighborhood. The man hurriedly carried the lad to the third floor of the house, and put him on a dirty bed in a still dirtier room. There was only one window in the room, and this was so high above the floor that, when the Italian went to open it in order to cool the air of the room, which was close and hot, he was obliged to stand on a chair. As soon as he had done this he shut the door and locked it, leaving the little fellow still sleeping.

Jamie did not wake until after the sun had gone down. The twilight, however, was sufficient to enable him dimly to distinguish things around him. When he opened his eyes he expected to see the familiar things in the pretty room he occupied at home with his mother. As he was still in a dazed condition from the effects of the chloroform it was some time before he became thoroughly conscious. But as he looked around the dirty room he remembered what had happened and immediately began crying at the top of his voice:

"Brother Tom, the bad Italian man has stolen me away; come and help me. Come help me, brother Tom. Come and help me."

Jamie had a strong voice and made such a noise that the man, Pietro, opened the door and said roughly to the boy:

"Stop that noise, or Pietro will whip you."

"I want brother Tom. You bad man take me to brother Tom."

As Pietro turned to another part of the room to get a whip, not supposing for a moment that the little fellow would run downstairs, he was both surprised and alarmed when Jamie rushed out of the room, ran downstairs, calling out at the top of his voice:

"Brother Tom, come and help me. The bad Italian man has carried me here."

The people in the house laughed and thought it a good joke and said to Pietro:

"Can't you keep a little kid like that quiet?"

Had Jamie been older he would have seen at once that the people of the house, while having no part in carrying him off, were in sympathy with the Italians. As it was afterwards discovered, they were a band of thieves the police had for a long time been trying to capture, but so far unsuccessfully. Fearing the cries of the child would attract the police, one of them said:

"Take the brat upstairs, Pietro, and teach him not to cry again by whipping him."

"I'll fix him," said Pietro in a rage.

"Let me do home," said Jamie, struggling. "Brother Tom, come and help me."

With an oath, Pietro seized him and carrying him to the room shut the door, gave the little fellow a cruel whipping with a piece of rawhide, and then stifled his cries by holding the handkerchief saturated with chloroform to his nostrils until he again became unconscious.

The day following Jamie's kidnapping was a busy one for Tom, Rick and the rest of their boy friends. They were all greatly interested in what had happened and had scoured the entire neighborhood in endeavoring to aid Abe in his efforts to obtain information concerning the team and its driver that had been employed for carrying away the little boy. Nothing of value, however, had come from these efforts. It was now afternoon. Tom, Rick and Ralph were sitting in the laboratory, talking over the stirring events of the last two days. At last, Tom suddenly jumping to his feet, said:

"What chumps we are, boys."

"What do you mean, Tom?" enquired Ralph.

"Don't you remember Ah Lung Sing told us that when the Italians visited him the first time they wanted to know where our telegraph line went. When they obtained permission to go on the roof they stayed much longer than he had expected them to do. Let's go and see if they have done anything to our line."

"That's right," said Rick and Ralph, "let's go."

On reaching the roof, where Ah Lung Sing readily permitted them to go, they were surprised to find that some one had tapped their line, or, in other words, had connected another line with it, in such a manner that any messages passed between their houses over their line would also pass through the new line.

"Here is something in which Mr. Gordon can help us," said Tom. "Let's go and tell him about Jamie, the Italians, and this tapping of our wire, but let's be careful not to look as if we were at all surprised by what we have seen."

Boarding a trolley car, so as to save time, they soon reached Mr. Gordon's office. They had the good fortune to find him in, and disengaged. Mr. Gordon was very indignant when he heard of the kidnapping of Jamie and said:

"Such people ought to be hung. Stealing a little fellow from his home is almost as bad as killing him."

When Tom told him of the story of the tapped wire, Mr. Gordon said excitedly:

"This is a very important discovery you have made, Tom. Have you traced the line to see where it leads?"

"No," replied Tom, "I came directly to you. The Lieutenant in the police office in our district, who knows all that has happened, warned us to be careful what we did since he said we would be watched."

"The Lieutenant has a level head," said Mr. Gordon. "I'll have some of my best linemen make this examination. No one will be surprised when such men climb poles and examine lines. I'll have this done, and will communicate with the Lieutenant, who I know very well. You had better go at once and tell him what you have learned. Of course," he added, as Tom was about to leave the room, "you understand the importance of this discovery, and how necessary it is not to let any who are watching know that you have made it. This tapping of your line is by no means a new trick, and is known as 'milking a wire.' It is frequently employed by crooks, gamblers, counterfeiters, burglars, and the like, for obtaining important information. Of course you can see that it works both ways, since they could not only read what is passing over your line, but you could in the same way discover what is passing over theirs. But you had better get off quickly and let the Lieutenant know what you have learned."

XXVII.

WHAT CAME OVER THE NEW TELEGRAPH LINE

When the boys left Mr. Gordon's office it was near five o'clock.

"There will just be time to call on the Lieutenant at the address he gave us." So they went to this address. They not only found the Lieutenant in, but did not even have to ask for him, for the man who came to the door appeared immediately to recognize them although they did not know him, and led them at once to a back room, in which a telegraph instrument was clicking at a desk in front of which the superintendent was seated. As the door opened the Lieutenant opened his key, so that the instrument ceased sounding, and turning around and seeing who his visitors were, he closed the key, and signalled to his correspondent.

"Wait."

"Well, Tom," he said, "I see you have something important to tell me."

As soon as he heard of the tapped wire he was greatly pleased and exclaimed:

"This is a more important discovery than you probably think. I hope you took the thing quietly, and have made no effort to see where the line leads. I don't think it likely that the Italians would run a private line themselves. They have probably got permission from some crooks with whom they are acquainted to use their wire. I think that when the Italians visited the laundryman the second time and asked permission to go on the roof, they intended to disconnect their wire. If they have not done this, we may learn some of their secrets. I must now determine," he continued, "how to find where that line leads."

Tom then told the Lieutenant what Mr. Gordon of the Western Union Telegraph Company promised to do in the way of sending his linemen out to trace the wire.

The Lieutenant chuckled with delight when he heard this, and said:

"That's splendid, Tom; I know Gordon, he is a capital fellow. His company, too, would like to punish those fellows for tapping a wire, for the laws against this are very severe. I will make it a point to see him."

Then touching a bell a man came into the room, with whom the Lieutenant gave instructions in tones inaudible to the boys, except that they heard the words, Gordon and the Western Union Telegraph Company.

When the man left the room the Lieutenant turned to the boys and said:

"Can you read Morse messages readily?"

"Rick and I can," replied Tom, "but Ralph can't."

"If you can read this write it down there," he said, pushing towards Tom and Rick blank pads and lead pencils. And then calling some one on the telegraph line he sent this message:

"Send me something as fast as you can."

There came almost immediately over the line a long message, and when, after a couple of minutes, the instrument stopped clicking and each boy handed him a correct copy of what had been sent, he chuckled louder than before and said:

"Boys, you're wonders. Now you can help me greatly in this case. Go back to the laboratory and immediately after supper sit quietly in your room and if any telegraphic messages come over that wire make accurate copies and let me have them the first thing in the morning, unless I see you before that time. Take down whatever you hear, whether you understand it or not. I feared it would be necessary to send a man disguised as a plain clothes man to take these despatches, but it is much safer to have you do it."

He then turned to Ralph and said:

"I received the letter you sent me. It was from the Italians. I suppose you would all like to hear it." He then read the following letter addressed to Mr. Justice, written in a disguised hand.

"'If you want to see your little boy again alive, get together $50,000 in gold as soon as possible, and leave it to-morrow near midnight in a box, under a tree in one of the two small groves that lie between the foot of the hill at Belmont, Fairmount Park, and the Athletic field. There are three fairly large pine trees in the right hand grove as you come down Belmont hill towards the athletic field. Take the tree that lies nearest to the drive. Keep this from the police. You are watched, and if you attempt to inform the police we will leave the city and you will never again see your little boy.'"

"Do you know this place, boys?" asked the Lieutenant.

"I know it well," said Tom. Then he gave the Lieutenant a clear, concise statement that greatly pleased him, and set him chuckling again.

On their return home, the boys ate a hasty supper and soon met in the laboratory, where they sat talking over the exciting events of the day. Several hours passed without any clickings being heard on the sounder, but at last it commenced ticking at a lively rate. The message received referred to matters the boys were unable exactly to understand, although it was evident the conversation was between thieves, for the words, swag, plunder, plant, blunt, were frequently used. This conversation lasted for ten minutes, and kept the boys busy in recording it. At last a message came over the wire that they could understand much better. It was as follows:

"Did Guiseppe and Pietro pinch the rich man's kid?" The answer came:

"Yes, he is at the other den two squares from us. They took the youngster away in a carriage. Pietro told me all about it. I sent him at once to the laundryman's to cut the loop out."

"How much blunt are they holding up the old man for?" The answer that came was, "$50,000 in gold."

As the boys sat quietly listening to the instrument they heard a step near them, and were startled by a hand being placed on each of their shoulders. As they were about to start to their feet to protect themselves, they looked up and saw a stranger who at once taking off a false wig and beard disclosed the features of the Lieutenant of the police station.

"I heard what the new wire said for the last two minutes. Let me see the notes that you've taken."

As he read them rapidly over he chuckled more and more, saying:

"Boys, this is great. They have put themselves completely in my hands. When I learned that Mr. Gordon's men had traced one end of the line to a place near the race course in the northwestern part of the city and the other end to the southern part of the city but had not yet found where it terminated, I felt sure that we were on the track of a gang of thieves and counterfeiters that the United States Government detectives have been endeavoring to locate for the past two months. You have not only aided the law very much in what you have done, but I think there is very little doubt but that we shall soon get Jamie back again. Can you get an early breakfast to-morrow morning, and come to my other address at half past six o'clock?"

"Certainly," said the boys, "we'll be there."

Tom and Rick were at the Lieutenant's private place a little before six in the morning. Rick at once handed him another note addressed to his father from the thieves, which the Lieutenant opened and read to the boys. It was as follows:

"Remember that to-day, near midnight, $50,000 in gold must be placed in a box under the tree named in the last letter. The money must be in gold, that can be melted, and not in banknotes or checks that can be traced. Do this if you want to see your little boy again. He won't keep quiet and we have to keep him under the influence of chloroform. He might die at any time; so don't fail to send the money."

"You see, boys," said the Lieutenant, "how important it was not to let his mother or Mrs. Justice read these letters. They would have greatly worried them."

"Father got home last night," said Rick.

"I know," said the Lieutenant, "he called on me before he went to your house. He is willing to pay the $50,000 in gold to release Jamie, but I told him to leave the matter in my hands and I would get the boy without paying any money to the kidnappers. I told him, however, that of course he knew he was watched, and advised him to openly draw $50,000 in gold from his bank, and immediately lock it up in the safe in his office. The thieves will hear of this, and will, therefore, believe they are going to get the money.

"I have heard from Mr. Gordon where the other end of the line ends. We know, therefore, from the message received over the tapped line, 'He is at the other den two squares from us,' that Guiseppe and Pietro live somewhere within a few blocks of this place, or somewhere in a district that is four squares in length and breadth. This is a fairly big piece of ground, and we must plan to have it watched; for, of course, Guiseppe and Pietro can probably be seen in the neighborhood. None of my men have even seen Guiseppe and Pietro, but you boys have, and I want you to help me, will you do it?"

"Yes," said both boys, immediately.

"You might think," he continued, "that I have already pinched the gangs at the places the line ends. I haven't done this, for I want Guiseppe and Pietro as well as the gang with whom they are staying. I have had the other dens spotted, so that none of the men can escape. When we locate the other place we will have three gangs of thieves at our mercy."

Tom was about to speak when the Lieutenant continued:

"Yes, I know what you are going to say. If I pinched these two gangs the others would be off and take Jamie with them, so there would be no chance of getting the lad. That's the reason I wish you two boys to help me."

"We're ready," said the two boys.

"That's all right," said the Lieutenant. "Now I want you to hang around the section of the city near the streets named, and keep on the lookout for these men. They may have changed their appearance, but you are bright boys, and I'm sure you will be able to recognize them. This is dangerous work, for if either of these men or the thieves thought you were spotting them, they would not hesitate to kill you. Are you willing to take the risk?"

Rick joined with Tom in saying without hesitation, that he would be glad to do what the Lieutenant asked them. Tom, however, added:

"Rick, I don't think you should do this without first speaking to your father about it."

"That's all right, Tom," said the Lieutenant, and was about to continue talking to them when he was called out of the room, so he said to the boys before leaving:

"Wait here for me, I'll be back in a few minutes."

XXVIII.

THE TWO PEDDLERS

When the Lieutenant returned he said to the boys:

"I asked you to come here early because I wanted you to help me find where Guiseppe and Pietro live."

"I am ready to go," said Tom, "and that too without speaking to mother. She is now almost worried to death over Jamie's absence, and if she thought I was going to be exposed to danger it might be a serious thing for her health, but I don't think it would be right for Rick to go without first asking his father's permission; do you?" he asked, turning to the Lieutenant.

"No, Tom," was the reply, "I would not be willing to take the responsibility of having you or Rick undertake this dangerous work without at least Mr. Justice knowing something about it. I have already seen that gentleman, and told him exactly what I wanted you to do. He hesitated considerably at first, but when I assured him that I would have a number of my officers disguised as plain clothes men in the neighborhood to look after both of you, he consented. He also agreed with me that it would be best not to say anything to Mrs. Bronson about Tom, and said he would take the responsibility of advising Tom to go."

On hearing what the Lieutenant said, the boys remarked:

"We are ready, sir, to go and do what you ask."

"Then come with me into this room and I will fix you up. I have a number of disguises prepared for you. Put these things on, and I'll fix you up so your mothers would not recognize you should you meet them on the street." He then gave each boy a suit of clothes like those generally worn by peddlers who walk through the streets offering their wares for sale in the poorer sections of the city.

As the boys commenced putting on the disguises Rick still retained the fine linen shirt that he always wore, as well as his custom-made shoes.

"Oh, come," said the Lieutenant, smiling, "that will never do. The shirt and shoes don't match with the rest of the suit and would be sure to attract attention."

As soon as Rick made the necessary changes, and both boys were dressed, the Lieutenant applied a brown-colored liquid to their faces and hands, thus changing the color of the skin. Then, with a dark pencil, he added a few lines to the forehead and face, which greatly altered their appearance. He now gave them a few lessons in walking around the room and saw that they knew the names of the articles they held in the tray each carried by means of a strap placed around his neck, saying:

"You will find the prices of the articles marked on them. Be sure you don't offer to sell them at prices below those marked as this would make people suspicious."

Fearing the boys, especially Rick, might be inclined to regard the undertaking as a joke, he said gravely:

"Boys, this is no joke. It is serious business. You are going among people who would not hesitate to kill you, if they thought you were threatening their liberty. This is the district in which I wish you to offer your goods for sale," mentioning a part of the city between 7th and 9th Streets in the southern part of the city.

He then gave each boy a small metal whistle, saying:

"I will have plenty of men on the street as plain clothes men. They will look after you, for I will have you pointed out to them when you enter the district. If either of you get into a dangerous position and need help, sound two blows on the whistle in this way," he said, producing the sound himself. "But don't use the whistles unless you get in a tight place. Now remember I want you to keep your eyes open, and if you should meet the two Italians, Guiseppe or Pietro, or both, try to find out where they live. As soon as you have this information walk straight through the district to the north with your trays held more to your right instead of in front. Before you go far, one of my men will come up to you and say:

"'I am the man you are looking for.'"

"If you recognize him tell him what you have learned, if not, say nothing. If you know him and he wishes one of you to go back with him do so, and let the other return and keep watching."

The boys felt very strange in their disguises. As they walked down the street and met people they knew, they felt sure they would be recognized, but as these people passed apparently without noticing them they concluded the disguises were better than they had thought.

At last, to the great surprise of the boys, they saw Mrs. Bronson coming directly towards them on the same side of the street.

"Now, Tom," said Rick, "we are in for it. If your mother don't know us we are all right."

Mrs. Bronson stopped and actually bought some pins and a dozen pearl buttons from Tom, without ever for a moment recognizing him.

"Well, Rick," said Tom, as they passed on, "if mother didn't know me, I guess I'm all right."

Boarding a Ridge Avenue trolley car, and taking an exchange ticket, the two boys were soon in the suspected district, keeping a sharp lookout for the two Italians. They did not keep close together, although they generally remained within calling distance. They found no difficulty in readily selling many of their goods, for, the people in the streets through which they were walking, seemed to prefer buying goods from peddlers like themselves, or from the outdoor stalls that were placed in front of the houses, on which all kinds of articles were exposed for sale, than from the larger shops. They were pleased to see that no one for a moment believed they were other than real peddlers, who were obliged to work for their living.

Several hours passed without any signs of the two Italians. At last Tom, who was trying to persuade a woman to purchase something from him, and was about turning away, heard the faint clickings of the snapper sounder that Rick, who was a short distance behind him, was operating while holding in his pocket. Listening intently, Tom was able to detect the following message:

"Pietro is coming down the street."

"Where?" signalled Tom from the sounder he also held in his pocket.

"On the other side," came the message from Rick.

Tom looked up for a moment and saw the villainous face of the Italian coming slowly down on the opposite side of the street. He looked straight at Tom, but it was clear that he did not recognize him. As soon as the Italian had passed him, Tom sent the following message to Rick on his snapper sounder:

"Keep your eye on him, I will follow as soon as I can safely do so."

Rick leisurely crossed over to the other side of the street following Pietro, and was soon afterwards followed by

Tom. The Italian stopped at several stalls apparently making purchases for a meal, since he bought a loaf of bread, a bottle of milk, and a little fruit. The idea suggested itself to Tom that the Italian might be possibly buying breakfast for Jamie, so that it was with difficulty that he restrained himself from flying at the man and demanding the return of his little brother. Remembering the caution the Lieutenant had given him, he merely watched the man as he passed slowly up a side street entering the door of the house to which he had taken Jamie on the day of his kidnapping. Examining the house and its surroundings, so as to be able readily to recognize it again, the boys at once continued their saunterings in the neighborhood. After several hours Rick now heard the clickings of Tom's sounder and read the following message:

"Guiseppe is coming straight towards you."

As Rick saw the Italian approach he walked quietly into a shop, offering some of his wares for sale. Coming out again he saw Tom following the Italian, so he sauntered in the direction in which he saw they were both going. Guiseppe did not stop to buy anything but went straight to the house they had seen Pietro enter earlier in the morning. As Rick passed Tom the latter sent the following message by the sounder.

"Wait around here and watch if they come out."

The house the Italians had entered was in a street that extended almost due east and west. Sauntering carelessly to the corner of the first cross street to the east; *i.e.,* to one of the principal streets running due north and south, Tom entered into conversation with a woman at one of the stalls, and, looking at the goods offered for sale, tried to purchase some of them at a lower rate than that which she was offering to the public, pretending that he was desirous of replenishing his stock. Of course, his real object was to be able to place himself in such a position in which he could watch the house into which the men had gone.

Rick, seeing the plan which Tom had adopted, bought a slice of watermelon from a stand on the opposite corner, and seating himself on the curb, commenced eating it, keeping his eye on the house. The care which he took not to swallow any of the watermelon seeds might have made one believe he was greatly afraid of getting appendicitis, but, of course, what he wanted to do was to watch the house without seeming to do so. But do the best he could to make the time pass slowly, he was obliged to buy no less than three slices. At last, Guiseppe was seen to come out of the door of the house they were watching. They were talking so loud that it was evident they had no idea anyone near could understand what they were talking about.

As they passed Tom he heard Pietro say to Guiseppe:

"It's all right. He took the gold out the bank to-day."

The men now passed out of Tom's hearing, approaching Rick on the opposite side of the street, who heard Guiseppe say:

"Then I go to-night to the tree at Belmont, and you, Pietro, stay with the kid."

Rick's appetite for watermelon appeared to have suddenly ceased, for still holding a large portion of the last piece he had purchased in his hand, he got up and walked down the street to the south, or in the opposite direction to that taken by the two Italians.

At the same time, Tom suddenly agreed to pay the woman the price she asked for the goods, for taking twenty-five cents from his pocket, he gave her the money and placed the purchased goods on his tray and then slowly followed after Rick.

The boys passed down the street holding their trays as requested by the Lieutenant, when they had information, until they had reached a much richer district than the one they had left. At this moment a man dressed in plain clothes came up to the boys, and said:

"I am the man you are looking for."

Tom looked up, and not recognizing the man, said nothing, but looking more carefully saw that it was officer No. 481, who pretended to purchase some of the goods from Tom, at the same time saying in a low tone:

"Have you seen the men?"

"Yes, both," was the reply.

"Do you know the house they are stopping at?"

"Yes," said Tom, giving him the number of the house, and name of the street.

"Follow me at a distance," said 481. And then walking down the street for several additional squares Tom gave the man a full description of what they had discovered, when 481 said to Rick:

"Come with me and see the Lieutenant. He'll want to ask questions I cannot answer. But he will be pleased at the work you have both done, and he is a man who is not easily pleased." He then added:

"Go back, Tom, and keep an eye on the place. If they try to take Jamie away sound your whistle."

Tom went back to the place where he had seen the men and again walked through the streets offering his goods for sale. The streets were more crowded in the afternoon than they had been in the morning, so that he was able to find considerable trade, selling in all several dollars' worth of goods.

Later in the afternoon, to his great surprise, A. Phineas Skinner and Jerry Jones passed him. These were the boys he had punished so severely when they entered his laboratory and attempted to assault him. They looked at Tom as though they recognized him, but appearing to be in some doubt, passed him again. They soon returned and again passed him, closely scanning his face. At last Skinner came close to Tom and said:

"If you have any good pins and needles I would like to buy some. Come down the street further where it is cooler, and I'll look over your goods." At the same time giving Tom a peculiar look.

Tom hesitated at first, but at last concluded that he would do what Skinner asked. When they had gone five or six blocks to the north, and were in a more respectable neighborhood, Skinner said:

"Tom Bronson, I was sure I recognized you;" and then fearing that Tom might think he was going to attack him, said:

"Neither Jerry nor I have any bad feelings towards you. On the contrary, as soon as we heard Jamie had been kidnapped we made up our minds to do what we could to find him. Jerry, who was once a bad fellow, but who I believe is now all right, once belonged to a gang of thieves. He heard the other day that some of this gang had kidnapped a little boy living in the northwestern part of the city, and told me about it. At once we both suspected that the kidnapped boy was Jamie. Finding our suspicions correct we have been walking through this part of the city for several hours. Jerry, who is a bright boy, at last recognized you in spite of your disguise. We have not yet had any certain knowledge about Jamie, but we know the house in which the gang of thieves live."

And he then told him in a low tone its location. It was the house Tom and Rick had seen Guiseppe and Pietro enter and leave later in the day. Continuing, he said:

" We are here for the purpose of helping you. Neither Jerry or I will ever forget that instead of handing us over to a policeman, when we behaved so badly to you, you gave us a chance to repent. We are on our way to another part of the city where we hope to obtain more information. You had better go back and hang around the neighborhood."

Tom did this, again offering his wares for sale, and this he continued to do until about half-past nine o'clock, when, feeling hungry, he stopped in a restaurant at the corner of the first cross street on the west from the street on which the house he was watching was located. He took a seat at a table where he had a full view of the house he was watching, and ordered a cup of tea, a fried egg, and some bread and butter, which he began eating slowly. It was a dirty place, and the food was badly prepared, but Tom was a healthy boy, and had a good appetite. Moreover, he was not squeamish, and so made a fairly good meal. In order, however, to stay longer, he called the restaurant man to him, asked him to bring him some more bread and butter as he was very hungry. While here he saw Guiseppe and Pietro leave the house and walk towards the street in which the restaurant was situated. After talking together for a few minutes, Guiseppe apparently bid Pietro good-bye, and got on a north-bound trolley car marked " Strawberry Mansion."

" On the way to Belmont Hill, I guess," said Tom to himself. " This agrees with what Rick and I heard as the men passed us this morning in the street. I'll wait to see if Pietro returns to the house."

PIETRO NOW RUSHED TOWARDS TOM WITH THE UGLY-LOOKING STILETTO IN HIS HAND

In order to keep his seat without making the restaurant man suspicious, Tom now ordered a plate of ice cream and a piece of cake. Pietro went slowly down the street and again entered the house. Tom remained at the table until he finished his lunch and then went out in the street.

It was now halfpast ten. Tom walked slowly down the street and while passing the house on which he had kept his eyes for so long he felt himself suddenly seized by two men, who endeavored to draw him into the house. He struggled, and struck at them several times, but they were too much for him, and soon forced him into the house, bound his hands securely with rope, and threw him into the cellar.

Tom struggled to free his hands from the rope, and had succeeded in liberating his right hand when the door opened and Pietro entered with a drawn stiletto.

"How dare you track Pietro? I see you three, four, five times in the street, but no know you. When you were passing the door I knew you were Tom, the little boy's big brother. So I get man to help me bring you here, and now I'll kill you. You know too much." And then Pietro approached Tom with a villainous look on his face, and with the stiletto still in his hand.

Seeing that Pietro intended to kill him, Tom withdrew his hand that he had liberated, and taking the whistle from his pocket placed it to his lips and sounded it shrilly twice as the Lieutenant had instructed him to do. The sound of the whistle, together with the discovery that Tom had the use of his right hand, so astonished Pietro that he stood still for a moment, when Tom again twice sounded his whistle.

Pietro now rushed towards Tom with the ugly looking stiletto, but again stopped a moment when he heard the tramp of approaching feet in the street. The footsteps drew nearer, and, stopping in front of the house, were immediately heard entering the front door, and into the house. While Pietro stood listening the cellar door burst open, and a dozen policemen in plain clothes, closely followed by Rick, A. Phineas Skinner and Jerry Jones, rushed into the cellar. Tom at once recognized, in the man who headed the policemen, the Lieutenant of police. In a few moments they had overpowered Pietro, and handcuffed him. In the meanwhile, the other men had surrounded the house and taken into custody the band of thieves.

"Tom," said the Lieutenant, "is this the place in which you think they have Jamie in hiding?"

"I am almost sure of it," said Tom.

"Then follow me," said the Lieutenant to his men, running up the stair-case towards the third story.

Bursting open the door of the room they found Jamie dressed in dirty clothing lying on the bed sobbing. The cruel treatment given him by Pietro, together with the frequent application of chloroform, had already greatly affected the health of the child. He recognized Rick at once, and was about to run towards him, when all of a sudden he knew Tom, even in his disguise, and jumping into his arms cried:

"Oh, brother Tom, I knowed you would come to take Jamie to mother."

"Yes, Jamie," replied Tom, clasping his little brother Jamie in his arms; "we will go home now."

XXIX.

BELMONT HILL, FAIRMOUNT PARK, AT MIDNIGHT

The Lieutenant of police was immensely delighted with the success that had attended this first part of his work. He had succeeded in liberating Jamie without the payment of any money; he had three gangs of thieves, who had successfully avoided detection for nearly half a year, and had, moreover, taken the man, Pietro, who besides kidnapping Jamie was wanted in Chicago for a similar crime.

"Come, boys," he said to his men, "bring the police patrol as soon as possible. We must get out of this neighborhood as quickly as possible, or an attempt may be made to rescue the prisoners."

He then sent one of his men to call up the nearest police station and ask them to let him have a squad of men immediately. The prisoners, all of whom had been handcuffed, were hurried into the patrol wagons. His judgment about obtaining aid from the police station was good, for, as they were leading the handcuffed thieves into the patrols, a crowd of foreigners and crooks collected around the wagons, muttering something that sounded as though they intended to attempt to rescue the prisoners. When, however, the heavy tread of some thirty policemen was heard coming rapidly down the street, the crowd changed its mind and rapidly melted away.

The Lieutenant then instructed the captain of the squad of rescuing policemen to see that Skinner and Jerry Jones were safely taken out of the district, whispering to the officer that he suspected one of the boys had once been connected with the gang and had squealed on them.

The officer nodded his head and said that he would see that they were all right, as he knew that the thieves would have no hesitation in killing Jerry if he had once belonged to this gang and had betrayed them.

Then taking Tom, Jamie and Rick, together with one of the officers into a carriage with him, and instructing another officer to sit on the box along with the driver, who, by the way, was also an officer, he turned to Tom and said:

"I have just received word that the gangs at the other dens have been taken. But there yet remains work to be done. We must capture the other fellow, Guiseppe. Do you know whether he has started out yet for Belmont?"

"Yes," replied Tom, "while I was sitting in the restaurant at the corner of the street taking my supper, Pietro and Guiseppe came out of the house, and after standing on the corner for a little while, Guiseppe got on a car marked 'Strawberry Mansion,' and Pietro went back to the house."

What Tom told the Lieutenant evidently greatly pleased him, for he chuckled in a way that Tom had heard him so often before. Turning to the officer that sat beside him, he said:

"Well, what have you to say about my new detectives? Will they do?"

"They're all right," said the officer, in an admiring tone. "None of our best men could have done as well as this chap has," he said, turning to Tom. "Yes, and this chap too," he said, looking towards Rick. "I watched these boys several times as they passed me on the street.

They kept selling the stuff in their trays just as if they had been on the road all their lives, and as to the innocent way they walked up and down the street, looking at everything, and yet never letting one know that they were watching, I never saw anything to equal it."

"I thought you would like them," said the Lieutenant, still chuckling.

The officer, then turning to his Lieutenant, said:

"But these chaps did one thing, Lieutenant, that I couldn't understand. They have some way of talking with each other without one knowing it." And he then related to the Lieutenant one of the times when the boys signalled to each other with their snapper sounders.

"Tell me about it, boys," said the Lieutenant.

Placing his hand in his pocket, Tom took the snapper sounder and without drawing it out of his pocket, signalled in the Morse characters.

"We did it with this."

"Yes," said Rick, entering into the joke, and answering with his snapper sounder, "we did it with this."

The Lieutenant had no difficulty in reading the messages the boys sent him, and he chuckled all the more when he noticed that his officer was unable to do so. Turning to the officer, he said:

"I've told you several times you ought to learn telegraphy. Here these boys are ahead of you, and have been talking together with these things," and then turning to Tom he said:

"Show him the instrument you have been using."

Tom did this, showing it to the man, who examined it with admiration.

Turning to Tom the Lieutenant then said gravely:

"Boys, you have handled this thing splendidly. But, Tom, you came near being killed. Had it not been for Rick, who brought me full particulars of what you and he had discovered, and for Skinner and Jones who saw you dragged into the house, and came and brought me word of your danger, as I came running down the street with a squad of men towards the house and heard the two calls in the whistle just as we came opposite the door, Pietro would probably have struck you with this stiletto. I don't think more than one blow from the villain would have been necessary to kill you."

"Pietro bad man," said Jamie, "he beat me every day. See here," he said, opening a slit in his torn shirt, and showing where the rawhide had raised great welts on his little body.

When Tom saw how badly his little brother had been treated, he was very angry and said:

"If the law doesn't punish that man, he will certainly have to deal with me. The cowardly brute, to treat a poor little fellow in this way."

"Don't get excited, Tom," said the Lieutenant. "I think Pietro is bagged for life; for, besides what he has done here, which is a very grave offence, he is wanted in Chicago for another kidnapping case, and even if he escapes these, the Telegraph Company and possibly the U. S. Government will want him for tapping wires."

While they were talking the carriage was being rapidly driven towards Strawberry Mansion, which was reached in good time.

"We have only time," said the Lieutenant, looking at his watch, "to reach Belmont Hill a few minutes before midnight. While I should be glad to relieve the anxiety of Mrs. Bronson by letting her know that Jamie is safe, and also that of Mr. Justice, who has been very anxious for you, Tom, as well as Rick, I think we had better take Jamie with us and drive straight for Belmont Hill. If it were noised around the neighborhood that Jamie had come back the news might be got to Guiseppe. Now, I especially wish to capture this man, who I think has been wanted in Chicago for some time, not only for kidnapping but for counterfeiting."

Tom agreed that it would be best to follow the advice given by the Lieutenant, so that the carriage was rapidly driven towards Belmont Hill. In a few moments, however, the Lieutenant said to Rick:

"Did you fix that box with the Leyden-jar battery before you left this afternoon?"

"Yes," replied Rick, "I gave it to Ralph, who has gone with the two officers in plain clothes in a carriage to Belmont Hill. One of them will place it under the tree referred to in the letter."

The Lieutenant looking at his watch now leaned out of the window and said to the driver:

"It is getting late. Touch up your team, or it will be midnight before we reach the hill."

It was an exciting ride, as the carriage was driven rapidly through Fairmount Park. It was so unusual to drive rapidly at so late an hour, that the park guards they passed stopped the carriage. A few words, however, from the officer occupying the seat alongside the driver were sufficient. All the guards appeared to recognize him, and permitted the carriage to pass without further questioning.

There was a full moon that night. The shadows of the trees thrown across the road, formed a picture so odd that they all remembered it in after years. The air was heavy with moisture, and the grass wet with dew, but this only added to the beauty of the scene, since the dewdrops shone like gems in the bright moonlight.

Jamie was so tired after all he had passed through that he fell asleep in Tom's arms. The lad appeared to be troubled with dreams, and would cry out in his sleep:

"Don't whip me, Pietro, I won't cry out again."

This so raised Tom's sympathies that he could scarcely keep quiet, but he contented himself by hugging his little brother still more tightly, especially when the youngster would wake for a moment and say to him:

"I knowed you'd come, Tom, and take me home to mother. Will we be home soon now?"

"Yes, Jamie," said Tom, "we will be home soon. Now go to sleep again, brother Tom will watch and wake you as soon as we get home."

It was midnight when the carriage drove slowly along the drive leading towards Belmont Hill. When it passed opposite or to the west of the grove of trees referred to in the kidnappers' letters, just before it came to the bridle path that crosses the hill from west to east, they saw a man walking rapidly down the hill towards the tree.

The Lieutenant said nothing but merely touched the arm of the officer who was sitting alongside him, when both placed their hands on their revolvers.

As soon as the man reached the tree, he stooped to pick up the box. They recognized Guiseppe, and could see that he was apparently endeavoring to determine whether it had the weight it should have if it contained the $50,000 in gold they had demanded. The man was apparently satisfied with its weight, for the look of joy on his face became pronounced. At last, as if he wished to be sure that the gold was inside, he reached his hand to unlock the box by a key which had been left in the keyhole.

"Now; see him fall suddenly to the ground," whispered Tom.

The moment the man touched the key he acted as if he had been struck by a bolt of lightning; for, he fell senseless to the ground. At this moment, the Lieutenant, the officers inside, and the officer on the box who had jumped down ran up to the fallen man and slipped a pair of handcuffs on his wrists, but he still remained unconscious.

Although it was beyond doubt Guiseppe they had caught, yet the chief appeared disappointed; for, on comparing the features of the man with a photograph he held in his hand, he remarked:

"He looks something like the man I want, but the color of the hair and beard don't agree with the description sent from Chicago."

As the man was still unconscious the Lieutenant turned to Tom and said:

"I hope you haven't killed the fellow, Tom, for I want to hand him over to the law along with Pietro."

"There is no danger of that, sir," replied Tom. "He will be all right in a few moments."

In a few moments the man opened his eyes and apparently did not see any of them but Jamie, whom Tom had brought with him in his arms from the carriage.

"What are you doing here?" said the man roughly. "I'll call Pietro and tell him to thrash you."

"Look out," said Tom fiercely, "or I may give you a thrashing myself."

The man was now slowly regaining consciousness.

"Ah," he said, "big brother Tom, are you?" And then looking at the handcuffs on his wrists, and the officers standing around him, he said, dropping his assumed Italian dialect:

"So I have been pinched, have I? Tell me, Mr. Officer, what had you in that box? Something I wasn't looking for that knocked me senseless. I'm danged if I ever saw such a plant."

"Ha, ha," said the Lieutenant in a delighted tone, "you are not an Italian but an American," and then stooping down and looking more closely at the man he suddenly pulled a wig and a false beard from him, and again compared the face with the photograph he had in his hand and then said:

"You are the man I have been trying so long to find. It was a good make up," he said to the fellow. "You fooled me all right and I'm not easily fooled. I guess you chaps from Chicago are pretty bright."

"That's all right, Mister," said the fellow in a sullen tone. "I'm down on my luck, but tell me, was that lightning in the box?"

"Yes," said the Lieutenant, "it was lightning that struck you." Then turning to one of his men the Lieutenant now enquired:

"Where is the patrol wagon?"

"I hear it coming down the road," was the reply.

The Lieutenant now blew his whistle, and some ten men suddenly appeared as if they had sprung out of the ground.

"Take this man to our station. Four of you go with him. He is a slippery fellow. He must not get out of our hands now."

As soon as the so-called Guiseppe was placed in the patrol wagon, the Lieutenant and the officers went back to the carriage with Tom, Jamie, Rick and Ralph and said to them:

"Now we can safely send the good word to Mrs. Bronson and to Mr. and Mrs. Justice, who must, by this time, be very greatly worried by not having heard anything from us. Stop at the Mansion at the top of the hill," he said to the driver, "there's a telephone there."

In a few minutes the good tidings were sent over the 'phone to Mr. Justice's house that Jamie, Tom and Rick were safely with him, and would be home as soon as the carriage could be driven from the Mansion at Belmont.

Before leaving, the Lieutenant brought several sandwiches and glasses of milk to the boys, who were by this time quite hungry.

As they were driving home, Tom said to the Lieutenant:

"Do you understand why they tapped the wire?"

"Yes," was the reply, "I've squared it all. But I don't want to talk about it now."

It was a happy party that reached Mr. Justice's residence at about one A.M. Here they found Mrs. Bronson and Mr. and Mrs. Justice, who had been greatly relieved when they heard the good tidings that had been sent them over the 'phone from the Mansion at the top of Belmont Hill.

As soon as Jamie saw his mother, he sprang into her arms and said:

"Oh, mother, Jamie's so glad to see you again. Those wicked men did steal me away, but you won't let them do it again, will you?"

"No, Jamie," said his mother, hugging him, "they shall never get you again. But what have they done with your pretty clothes? Where did you get those dirty things you have on?"

"They tooked away my clothes and gave me these things," he answered, greatly disgusted with the dirty clothes that they had given him, and then continued: "Won't you dive me a bath, mother, I feel so dirty?"

The ladies took him upstairs to the bathroom, and were horrified on undressing the little fellow to see the cruel way in which his body had been marked by the beatings he had received from Pietro.

"Tom," said Mr. Justice, "you and Rick will find your clothes in Rick's room upstairs. Your mother and Jamie are going to remain with us all night. I think you and Rick had better go upstairs and take a bath. Ralph, you had better stay all night, too," he added. "Tom, you can stay all night just as you did when you acted as Richard's trained nurse."

Ralph's people had a 'phone in their house, so he used Mr. Justice's 'phone to let them know where he was, and stayed with them the rest of the night.

When the boys left the room, Mr. Justice turned to the Lieutenant and said:

"Lieutenant, you have handled this case admirably, and I hope you will accept this as a token of my regard for your services," handing him a check for $1,000.

"You are a very liberal man, Mr. Justice," said the officer. "It is a pleasure to work for a man like you, not only because you pay so well, but because you don't hesitate to praise work that is well done. But the boys have done splendidly too." And then suddenly changing the topic of the conversation he said to Mr. Justice:

"Can you find some work out of the city for that boy, Jerry?"

"Why do you ask?" enquired Mr. Justice.

"Because if he remains here he stands a good chance of being murdered. I suspect he had some connection with the gangs of thieves and crooks we rounded up to-night. They know he gave them up. Now such people never forgive one of their number for squealing on them, so that for the lad's safety we had better find him some work outside of Philadelphia, and, if possible, outside the state."

"I have some business relations in Omaha, Nebraska," said Mr. Justice, "where I can find work for the boy. Are his parents living?"

"No," was the reply, "he lives with a worthless uncle."

XXX.

CONCLUSION

Mr. Justice found a place for Jerry, who was apparently thoroughly reformed, and acted so as to give great promise for the future.

Pietro, and the so-called Guiseppe, were punished for their crimes, both in Chicago and in Philadelphia. As the Lieutenant had predicted, the term of years for which they were sentenced was so great that they spent the remainder of their lives behind the bars.

A. Phineas Skinner was a thoroughly changed boy. He had sincerely repented his cowardly attack on Tom. Indeed, he was so changed that Tom gave him his friendship again, and several months afterwards, when a vacancy occurred in the Society of the Jolly Philosophers, Skinner was admitted into the Society after a suitable initiation.

The first meeting of The Ancient and Honorable Society of the Jolly Philosophers, in September, was an event never to be forgotten by its members. Tom and Rick read a paper describing their telegraphic experiences. The story of the tapped wire, and the manner in which the new circuit led to the discovery of the gang of thieves, especially the part played by the snapper sounders, when Tom and Rick were on the lookout for Guiseppe and Pietro, especially attracted the attention of the boys.

Ralph read a paper on how to make and fly kites that contained many interesting points. It was by no means an easy thing to gain the attention of his hearers with a paper of this character, since the greater part of the audience consisted of those who believed themselves to be experts on kite making and kite flying. It, therefore, happened that at the beginning of the reading of the paper, most of them listened in an indulgent way, fully determined, on the conclusion of the paper, to discuss the many points which they felt sure would be omitted; but as they listened, and not only heard difficult points made plain, but many new points introduced, they soon concluded that the New England lad had probably forgotten more about kites than they had ever known, and therefore listened to him with rapt attention, as he gave them point after point on this branch of aerostatics. They were especially tickled with the description of the big kite that Tom, Rick and himself had employed on the Thoroughfare at Atlantic City, and its novel use in dragging them through the water. Nor did Ralph fail to give to Tom the credit of having first proposed its use.

But what the boys regarded as crowning everything else, and heaping honor on their society, was the presence of their adult friends, for Messrs. Alexander, Dodge and Gordon were with them from the opening of the meeting, while later, the Lieutenant of the police station in their neighborhood and Mr. Justice quietly came into the room. The gentlemen were all acquainted with one another and sat together in the same part of the room.

When the regular business of the Society was completed, while Tom and Rick were reading the paper on telegraphy, Mr. Gordon leaning over whispered to Mr. Dodge:

"Dodge, what do you think of this? Is this not a crowd of bright boys?"

"It is, indeed, Gordon," was the reply, "especially those who read the papers. If you get a chance," he continued, "tell the boys something about the wonderful things that can be done with wireless telegraphy. It would be splendid to get these boys thinking about such things."

"I shall," said Mr. Gordon, "and what is more, I intend to give them some simple apparatus for wireless telegraphy."

"That's all right, Gordon, but don't help them too much. It will be far better, in the end, if they are obliged to construct the apparatus themselves and thus get acquainted with its difficulties by actual experience."

"Dodge," said Gordon, "I hope you will give them some idea of electrical power, as well as a description of your station."

"I shall," was the reply, "and what is more I will see that they have the opportunity of visiting several other large stations in the city."

When the last paper was read, Tom, as president of the society, said:

"Boys, as you know, it is our custom to spend the last part of the evening in some of those things that have given our Society the name of the Jolly Philosophers, but we are honored to-night by the presence of visitors, who, I understand, are willing to say something to us. How would you like to put aside the fun for this night, and listen to what the gentlemen have to say? All those in favor of doing this will say, 'Aye.'"

It was so evident that every boy in the room voted in the affirmative, that Tom announced the motion as unanimously carried.

In introducing Mr. Gordon, Tom told of the pleasant visit he and Rick had made to the office of the Western Union Telegraph Company, as well as the generous gift of Mr. Gordon's to them of the Morse sounders and batteries. He also referred to the pleasant swim five of them had with this gentleman in the Schuylkill River at La Fayette, and of his subsequent present to them of the snapper sounders.

Mr. Gordon, in a short speech, told the boys about telegraphy in general and wireless telegraphy in particular, explaining to them the possibility of sending telegraphic despatches in all directions through space without the use of wires connecting the sending and receiving stations. He said among other things:

"You might suppose that wireless telegraphy is such a difficult thing that boys like yourselves could not possibly experiment with it. But this is not true. I am sure from what I have heard to-night, while in this room, that there are at least two boys here, if not more, who are capable of making such experiments. I want to say now that I shall be pleased to give you some little help, if any of you conclude to make these experiments, both in the way of apparatus and advice."

Mr. Dodge, who followed Mr. Gordon, told the boys of the power station of which he was chief electrician, and spoke of the large generators employed for producing electricity. He explained the wonderful manner in which electricity, produced in the neighborhood of large waterfalls, as at Niagara Falls and in parts of California, where power, transmitted over a distance of 20 miles at Niagara Falls, and over more than 200 miles in California, is employed at the distant ends of the lines for lighting streets and houses, propelling trolley cars, driving the machinery in mills, heating furnaces in chemical manufactories, and for many other purposes.

Mr. Alexander followed with an interesting description of electric lamps, both arc and incandescent, giving the boys a clear description of the manner in which incandescent lamps are constructed, as well as the various means employed for increasing the length of time the carbons can be used in arc lamps before they require renewing.

There were two things that especially characterized all these addresses. They were brief and were made by men who were not only well up on their subjects, but understood how to talk to boys. It is difficult to estimate the influence such talks have, when made to boys who are able to appreciate them. In the case of Tom, Rick and Ralph they led these boys to take up the study of telegraphy, electric motors, the transmission of power, and the construction of arc and incandescent lamps to such an extent that in a short time Tom's laboratory became the centre of a series of wonderful experiments, that were both wise and otherwise.

During the addresses of Messrs. Dodge, Gordon, and Alexander, Tom observed the Lieutenant of the police station and Mr. Justice come into the room, taking seats near the door so quietly that but few of the other boys had observed them. The boys were, therefore, surprised when Tom called on the Lieutenant and asked him to speak a few words to the boys.

The Lieutenant had not been talking long before the boys made the discovery that he was far from being the dreadful man they supposed he must be from the position he occupied. On the contrary, they found him to be a very jolly fellow, who had a funny way of chuckling when anything pleased him. This greatly tickled the boys; for, as is well known, boys do not take long to discover the peculiarities of people. The Lieutenant told the boys how much Tom, Rick and Ralph had helped him in capturing a desperate gang of thieves and gave them a brief description of what had occurred in the southern part of the city. He earnestly advised the boys to do what the previous speakers had suggested in taking up the new studies and experimenting with them.

"You can never tell," he added, "what unexpected use you may be able some day to make of these things."

When Tom asked Mr. Justice whether he would not say a few words, the boys made another discovery. They found that one cannot always be sure that because a man is generally quiet and preoccupied with his business affairs, he has no use for boys. On the contrary, Mr. Justice had a way of talking that captured the boys from the start, and he spoke so as to set them thinking of how important a thing their lives were, not only to themselves but to the rest of the world. He added, however, that he by no means wished them to be solemn or grave all the time. On the contrary, he said he especially liked to get among a jolly lot of boys. He understood they had set aside their usual fun for the evening, which, to a certain extent, he regretted, and for which he would try to make amends. He then commenced telling them a lot of stories that were so funny that he soon had all the boys shouting with merriment. Then suddenly stopping, he said:

"But I must now stop talking, for I hear the rest of my speech coming up the outside steps."

The idea of the rest of Mr. Justice's speech coming up the outside stair-case greatly surprised the boys and made them listen intently. When the door opened and some men from Pflaumer's, the confectioner's, came into the room lugging a big ice-cream freezer after them, followed by another man with a large basket of fancy cakes, they understood. Thanks to Mr. Justice, it happened that the

Jolly Philosophers, not only got the speeches, but did not lack fun at the close of their meeting.

Tom, Rick and Ralph continued their studies, and bid fair to become well-known scientific men. Their further experiments and adventures may some day be described in another volume.

THE END.

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